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ABSTRACT

This volume of the Center for Excellence in Education (CEE) monograph series describes Northern Arizona University's (NAU) commitment to education and innovation. Contained within this volume are discussions of professional development courses and programs in the area of educational technology. The articles in this monograph feature educational reform through the implementation of constructivist learning principles in classrooms. The monograph is divided into two parts. Part I's theme, "Changing Attitudes about Technology in Education," contains the following papers: "Professional Development and Innovations: Creating Environments for Practice," (Cathy L. Gunn), and "Building Communities of Learners in Technology Classes: Strategies that Promote Confidence, Problem-Solving, and Critical Thinking," (Elizabeth M. Willis and Laura Sujo de Montes). Part II's theme, "New Technology Paradigms in Highly Technical Learning Environments," includes the following papers: "Instructional Strategies for Developing a Teaching and Learning Technology-Based Curriculum," (Glenda A. Gunter and Judy R. Lee), "Guiding Principles of Constructivism: The Didactic Concepts behind the Development of the Grand Canyon CD-ROM (Gary R. Tucker), "A Constructivist Perspective on Distance Learning," (Kathleen K. Glascott and Sandy J. Stone), and "Rethinking Learning Environments: A Team Investigation of Beliefs and Practice" (Gary R. Tucker and Cathy L. Gunn). Author profiles are included at the end of the document. (AEF)

PERSPECTIVES

TECHNOLOGY, INTEGRATION, AND LEARNING ENVIRONMENTS

CEE MONOGRAPH: THE NAU CENTENNIAL YEAR OF EDUCATION

GARY TUCKER & CATHY GUNN
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FOREWORD

This volume in the CEE Monograph series is being published during the Year of Education for Northern Arizona University. The Year of Education is part of Northern Arizona University's centennial celebration, and is intended to draw attention to the important role Northern Arizona University has played and continues to play in education. From its inception as Northern Arizona Normal School in 1898, this university has consistently demonstrated a strong commitment to the preparation of qualified educational professionals. This commitment was revitalized in 1984 with the creation of the Center for Excellence in Education. At that time, the faculty in the Center were challenged to find innovative and better ways to prepare educators. This challenge continues to be a cornerstone of the CEE mission as today's faculty strive to prepare professionals who can "create the schools of tomorrow."

I believe this monograph successfully captures the Northern Arizona University commitment to education, and more specifically to innovation. Contained within this volume are rich discussions of professional development courses and programs in the area of educational technology. These descriptions are worthwhile in themselves, but the monograph is much more than a simple compilation of program descriptions. The articles in this monograph are also about educational reform through the implementation of constructivist learning principles in classrooms. The authors demonstrate how ideas like constructionism and distributed cognition can form the basis for reconceptualizing learning environments through technology. These ideas are made even more powerful by the authors' honest appraisals of the difficulties inherent in this reconceptualization process.

In conclusion, I feel honored to have been asked to write the foreword to this important volume in the CEE Monograph series. Students of educational technology and learning theory will profit from the valuable insights contained within this volume.

Thomas G. Fetsco, Ph.D.
CEE Centennial Professor
April 28, 1998

INTRODUCTION

The defining technology of the ancient world was the simple but elegant technology of the hand (Norton & Wiburg, 1998). It is through the hands that the human spirit manifests itself. The Native American healing hand on the cover of this monograph can be thought of to suggest a connection between the guiding force and the products of our technical tools described within. Norton and Wiburg remind us that "Ancient craftsmen manipulated their world with tools that were extensions of their hands. Thinking 'through' the technology of the hand, ancient philosophy was firmly rooted in a concrete world, examined with a craftsman's practical experience" (p. 5). The chapters you find in this Center for Excellence in Education's Centennial Year of Education Monograph remind us of that concrete world of education and the need for examining the learning environments created with technology with an eye towards practical experience. The authors share their experiences in learning environments of change and uncertainty, of challenge and complexity, and of wide possibilities. Technology is found in each of the learning environments described, but the technical components are secondary to the teaching and learning enterprise.

The monograph is divided into two parts; Part I follows the theme of Changing Attitudes About Technology in Education while Part II maintains the theme of New Technology Paradigms in Highly Technical Learning Environments. In the first chapter of Changing Attitudes About Technology in Education, Cathy Gunn provides the context for a university-school professional development partnership in her paper *Professional Development and Innovations: Creating Environments for Practice.* In this project, technical innovations were introduced to K-12 teachers, including the development of an inservice CD-ROM. Three approaches are presented: a) computer-aided instruction development in curriculum teams, b) constructionist versus instructionist school improvement, and c) the difficult constructionist learner socialization process. A discussion on creating constructionist learning environments with teachers concludes the chapter. In the second chapter, *Building Communities of Learners in Technology Classes: Strategies That Promote Confidence, Problem-Solving, and Critical Thinking*, Elizabeth Willis and Laura Sujo de Montes present and discuss two university courses with the same content–one on-campus with face-to-face instruction, the other a distance class where the teachers and learners were physically separated. The authors examine the learning strategies used and the change of attitudes by key players as a community of learners was constructed.

Part II follows the theme New Technology Paradigms in Highly Technical Learning Environments with *Instructional Strategies for Developing a Teaching and Learning Technology-Based Curriculum* by Glenda Gunter and Judy Lee. This chapter describes the restructuring of a graduate-level course to include technology-based experiences with the intent of better preparing education graduate students for a technology-rich environment. A description of the

course, along with challenges and solutions, is presented. Gary Tucker, in his chapter *Journey Through the Canyon: A Review of the Design Strategies of the Grand Canyon CD-ROM*, discusses the challenges of effective interactive multimedia design as an attempt was made to use the latest theories to fuse learning objectives into a coherent unity using the Grand Canyon as a context. The chapter reveals an examination of the multimedia design and provides an explanation of how this model allows users the freedom and support necessary for learners to construct their own knowledge.

Sandy Stone and Kathleen Glascott report on a study conducted at two universities where student perceptions from a constructivist perspective were compared in a traditional classroom versus an interactive television classroom where students and instructors were separated physically. In their chapter, *A Constructivist Perspective on Distance Learning*, a comparison of the behaviorist and constructivist theories of learning is provided as a background to explore the constructivist paradigm within highly technical distributed education classrooms. Suggestions on how to modify interactions and technological supports to effectively use this model in the context of distributed education are included.

The Monograph and Part II conclude with the chapter entitled *Rethinking Learning Environments: A Team Investigation of Beliefs and Practice* by Gary Tucker and Cathy Gunn. In this chapter, the authors share the process of exploring their beliefs and teaching practice in a team-taught university course using interactive instructional television for course delivery to two university classroom sites in Arizona. The course was supported by computer conferencing and a WWW site. Included are personal reflections on experiences that relate to creating technology and Internet-supported learning environments that follow a constructionist point of view.

Gary R. Tucker and Cathy L. Gunn
Issue Editors
April 28, 1998

Reference

Norton, P., & Wiburg, K. (1998). *Teaching with technology*. Fort Worth, TX: Harcourt Brace.

Part I

Changing Attitudes About Technology in Education

PROFESSIONAL DEVELOPMENT AND INNOVATIONS: CREATING ENVIRONMENTS FOR PRACTICE

Cathy L. Gunn

A telecommunications and multimedia inservice project sponsored by the Center for Excellence in Education (CEE) at Northern Arizona University (NAU) and by the US West Foundation included the study of an evolving professional development venture that connected university-based preparation with ongoing education of teachers. Twenty-four teachers from six geographically diverse regions of northern Arizona–from rural Reservation to agricultural valley to mountain community–participated in the Telecommunications, Environmental Education, and Multimedia (TEEM) project. The two-year TEEM project was funded July, 1995, through June, 1997; however, the partnership between participants–K-12, university, and community–extends beyond the funding period. This chapter provides the context for the university-school partnership with a description of the project and the CD-ROM product that resulted. A description and discussion of technology innovations introduced in the project follow, with a short discussion of strategies used to create constructionist learning environments for inservice teachers. Three approaches are presented: (a) computer-aided instruction development in curriculum teams, (b) constructionist versus instructionist school improvement, and (c) the difficult constructionist learner socialization process. The chapter ends with a description and discussion of a constructionist dilemma confronting the project director/author.

The TEEM Project

In this project, national standards in geography, math, and the arts (music, drama, and visual arts) were brought together with Arizona Department of Education environmental education (EE) guidelines to address concerns that schools should be developing and using coherent integrated curriculums. State EE guidelines were chosen in an effort to increase teacher attention to promoting and maintaining a sustainable future. Integration of the content areas of geography, math, and the arts fulfilled a need to integrate an area such as environmental education across diverse curriculum content. This unusual marriage of disciplines presented a real-world problem for teachers as they investigated their own practice and worked towards an integrated curriculum in their classrooms. Multimedia and telecommunications technologies were naturals in supporting integrated curriculum development and in supporting this developing community of teachers from diverse, rural, and remote locations.

Teachers in the project were introduced to multimedia components (e.g., still video cameras, scanners, presentation software, projection devices) and the use of these components integrated within the K-12 curriculum. They were also introduced to telecommunications: e-mail, listservs, the World Wide Web, HomePage creation, web page design, and integration of web-based resources in K-12 classrooms.

Teacher teams developed EE lessons and instructional multimedia modules based on an environmental waste material theme. Teachers worked with instructional design specialists, programmers, artists, and content-area specialists to develop classroom lessons, activities, products, and resources. Modules were linked and then reproduced on a CD-ROM to provide resources for participant teams for inservice purposes in their schools and in CEEs teacher education program.

The Product

The CD consists of introductions to telecommunications, multimedia, curriculum integration, using one computer in a classroom, assessing student multimedia projects, on-line search strategies, background information on the change process, and equity issues. National standards in math, geography, music, theater, and art, as well as Arizona environmental education standards are found on the CD. The CD houses an extensive bibliography, 31 lesson plans or activities, samples of student-created multimedia presentations, and profiles of the project members. Each lesson plan or activity has links to related national or state standards and are cross-referenced throughout the CD. Through search strategies or by menu, a teacher can locate lessons related to math, lessons about the use of composting, or all lessons related to a specific environmental goal (or national standard). Lessons are also linked to informational resources, such as "Multimedia How-To" or "Telecommunications How-To" if there is a multimedia or telecommunications component to the lesson. Related video clips, student presentations, or background information are also available as links to lessons.

All lessons are also linked to actual web pages which have been "whacked" through two levels to illustrate how the web can be integrated into the teaching and learning process. For example, "Protect our Planet," a play written by an elementary class, has links to a playwright interview, information on another environmental play, and a web page on how to assess students in theater. A middle school lesson titled "Garbage Graphing" includes links to landfill information, a graphing lesson, and information on solid waste management. Because it contains a telecommunications and a multimedia component, the lesson is also linked to "Telecommunications How-To" and "Multimedia How-To" pages. The telecommunications and multimedia how-to pages include photos of equipment, a video clip on how to scan materials for digitizing, examples of multimedia presentations, scanned student art work with accompanying audio explanations, and video clips of teachers talking about how the use of computers might enhance student learning. Lessons, standards, and text based on highlighted issues can be printed for teacher use.

The CD-ROM disc has been made available to the participating schools, to the US West Foundation, and to the Center for Excellence in Education for use in its teacher preparation program. Information from the CD is also made available at a project web site and is one method for continuing the project outcomes beyond the funding cycle.

The first year of the project consisted of participant training in the use of technologies and the creation of the CD-ROM. In the second year of the project, teacher-participant teams planned and provided nine hours of professional development inservice to their peers using the CD-ROM disc to begin development of school-wide integrated environmental education plans, with inservice also emphasizing telecommunications and multimedia technology applications.

Viewing the CD-ROM disc produced by the TEEM teachers cannot begin to illustrate what learning occurred for everyone involved in the project. Data collected throughout the two-year project has been analyzed and a summary of the data is presented to provide readers with a glimpse of what we learned from this project.

Summary of Project Data: What Do We Know?

Analysis of data collected (participant and staff journals, surveys, workshop evaluations, field notes, and listserv messages) produced the following summary information. At the project's beginning, participants generally had prior experience with technology but were less confident in sharing their skills with pupils and colleagues. They were especially weak in Internet skills. After a half year, the project had impacted a large number of people in the participating schools and school districts–2,500 people. We saw an increase in the comfort level of the participants in sharing technology in their classrooms and with other teachers; their Internet skills developed and they began to use specific hardware and software with an eye to the curriculum. These skills were further enhanced in an intensive two week summer seminar at the half-way point of the project. By the three-quarter mark, participants revealed an increased sophistication in their understanding of the complex web of interacting factors contributing to successful integration of technology in the curriculum and how to control those factors. By the end of the project, they exhibited a high comfort level in conducting workshops. From their appreciation of the obstacles they faced and their acquired knowledge of how to overcome them, it was apparent that they had been groomed for a leadership role in their schools and communities.

To what do we attribute the success of the project? We studied the process of change very carefully throughout the project. In reviewing journals, workshop agendas and evaluations, and through a focus group conducted three-quarters of the way through the project, we found several themes repeated in the data.

Themes

Attention to process of change. The long-term goals at the start of the TEEM project in the late summer of 1995 included the following:

1. Pedagogically sound and location-specific means for training and preparing both preservice and inservice teachers.

2. Integrating environmental education across the curriculum.
3. Learning about and making use of the Internet for the following purposes:
   - communication,
   - data sources,
   - collaborative projects, and
   - as a repository for teacher and student-generated resources for environmental education integration (Gunn, 1994).

Short-term goals included

1. creating a pedagogically sound instructional CD-ROM disc for teachers;
2. training applications of an infrastructure for environmental education; and
3. providing a "trainer of trainer" model for school-based staff development (Gunn, 1994).

Changes in the goals concerned the shift of focus with the curriculum development from environmental education issues to technology issues. As part of the long-term goal (see #2 above), environmental education was the curricular focus. During the course of the first year, the focus shifted to technology techniques and innovations. During the first year, the learning and changes took place slowly and at varying paces among the participants. This pace was affected, among other things, by the school context, including administrative and technical support as well as availability of technology. To provide as much local support as possible, teachers were visited in their school locations several times throughout the project to tailor inservice to their specific needs. For example, an undergraduate student in NAUs engineering program, Brian, was hired to visit each school site and to engage in a needs assessment for connectivity. Brian talked with teachers, administrators, and district technology experts. He was able to provide detailed plans for connectivity when needed, and in some cases, was able to physically connect a teacher for telecommunications access. Nicole, the project technical advisor, also visited school sites and helped them locate unused multimedia-related equipment, such as a scanner, or helped teachers and administrators determine what equipment might be purchased. In several schools, equipment had been purchased by a teacher or administrator who had since left, leaving equipment unused. In other schools, equipment was found in closets because no software had ever been purchased to make the equipment operable. Nicole helped participants order software and provided training on found equipment. The project director/author met with teacher teams at their school sites after NAU on-campus instructional workshops to apply what was learned in a university computer lab to their own individual situations and to determine teacher concerns and needs for the next round of workshops.

The project enabled a group of individuals working at different schools to build a sense of community from which they were able to draw strength and

support as they progressed in their own school sites. Though the participants had a comparatively high interest in technology in education, most had concerns of under-training and lack of technical knowledge at the beginning. We feel that the sense of community helped the participants in making the important transition from novice to technical expert in their schools, as well as becoming resource persons in their schools. As they gained more confidence, the focus of their concerns shifted from personal experience to integrating technology across the curriculum. Thus, by the end of the project, their primary concerns focused on actually disseminating what they learned.

Addressing the change process explicitly. An unintended outcome of this project has been the development of strategies to address the change process when teachers are introduced to technology innovations. Six months into the project, a turning point came from the use of innovation continua with teachers determining both self and group movement or change on a continuum for each innovation (see Figure 1). We asked each participant to mark their location on each of nine innovation continua. We then determined where the group was on a single innovation. The use of these continua throughout the project brought teachers together as a working group as they saw themselves fitting into the project as one of a group with potential for movement along each continuum.

Innovation #1: Telecommunications Innovation Continuum - Levels of Use

training	access	e-mail	listserv	student access	integrated into lessons

Figure 1. *Each column in Innovation #1 represents a continuum from non-use or orientation on the left to full implementation on the right.*

Once the innovation continua were introduced graphically and used by teachers personally and collectively to mark their progress, they began asking for other continua to be developed later in the project. For example, during a summer 1996 workshop, a group of participants developed their own continuum to show progress in developing environmental lessons for the CD-ROM. Wall-size posters of project tasks and training topics for workshops (e.g., progress in learning to use presentation software, web page development, the conceptual design of the CD-ROM) were created and used periodically to show group progress. Whole-group debriefing sessions centered on these wall posters to guide the next day's work. Colored Post-it® Tape Flags were used as markers and were moved by participants to indicate a group consensus of progress. Discussion established that although individuals might have moved up on levels of use, group growth reflected a definite location on the continuum with some individuals seen as outliers. It seemed appropriate then, that when a group of participants met to begin CD-ROM design, graphic continua were used to determine progress of design, content, and programming tasks. These strategies are currently being tested in other technology innovation professional development projects.

Participant recognition of change. We encouraged participants to verbalize their concerns whenever possible. This request was, of course, suspect at the beginning of the project. But by the second quarter, participants began to note on evaluations that the project staff was listening to them. Changes were sometimes made in workshop content and structure in the course of one day with the use of "exit" cards. At the end of one session, participants were asked to list on an index card their concerns and also one thing they could take with them and apply immediately. After several occasions of addressing concerns and needs, participants must have started trusting the system because they began sharing more frequently.

During a workshop one-quarter into the project, participants completed a survey titled "Changes." Four major change themes, or variations in beliefs and/or practice, were identified from open-ended statement/essay type responses to characterize the changes perceived during the first quarter.

Variation One. Change in attitude toward technology was identified as the key change to the participants. This change of attitude was toward both personal and professional use of technology. Out of 14 respondents, 12 identified this attitudinal change.

Variation Two. Change in knowledge and skills of technology was identified as a close second in the responses. Out of 14 respondents, 10 identified an increase in skills/knowledge in using technology that included personal and professional use.

Variation Three. Change in the classroom through the use of technology was identified by many of the respondents. Out of 14, eight described a change in their teaching and the increased use of technology by their students in the learning process.

Variation Four. Change in their roles as teachers was also identified strongly by many respondents. Out of 14, eight wrote of changes within their school with them playing more of a leadership role or being considered an expert concerning technology (with some indicating shock that this would be so). The isolated role of the teacher, now networking with other colleagues or teachers in other schools, was also identified in the role change.

After one-half year, the comfort level of the participants in interacting with technology had been greatly extended. A majority of the respondents expressed an improved attitude towards technology, more advanced skills, and the ability to share this with students and colleagues. The only concern expressed by a majority of the participants was the need for a uniform curriculum with regard to environmental education. Concerns expressed by less than half of the participants involved levels of support and the need to improve their own skill. There was an obvious tension among all project participants, including project staff, at this point in the project. The tension seemed to revolve around the CD and its content. Suddenly, everyone, including project staff, were doubting that we could pull together a CD to model integrated curriculum. A summer seminar was approaching and it was obvious to project staff that for the project and the CD to be successful, teacher participants

would *have* to take responsibility for the next stage of CD development. But how was that to be accomplished?

Managing Change in Practice

The CD-ROM disc is not just a how-to guide on integrating technology with teaching. Participants included modeling through examples which exemplify true integration. For example, a user of the CD can choose to view a PowerPoint presentation created by a combined 2nd/3rd grade classroom of a field trip to a landfill and the process they used to collect data at the site. Lessons can be accessed on CD which are linked to state and national standards, to supporting information such as how to use multimedia or telecommunications in the lesson, and to web sites which support the lesson. Preservice students should benefit from the integration modeling found on the CD as it is used in methods courses at the university. But perhaps more importantly, the teachers in the project went through a two-year journey of finding out what it is like to be learners in a constructionist learning environment (more on this below). The teachers themselves were encouraged to provide direction for the project content and the final product. Each workshop was planned around teacher concerns and supported their evolving "control" over the project. This journey was long and arduous, but through reflection (journals, evaluations and surveys, focus groups, small and whole group conversations) most teachers left the project with a new or renewed sense of the effect of creating active and constructionist learning environments for and by the learner. Teacher comments indicate that their K-12 classrooms will never be the same.

The project was completed formally on June 30, 1997, but activity in this area continues. Several teacher teams planned a series of on-going workshops in their schools during the following school year to continue what they started in spring workshops. An elementary team submitted a telecommunications integration grant and received funding for a project between an urban school and a Navajo Reservation school. The grant provides computers for two teachers at each school site, on-line and telephone support, and virtual training seminars. The principal at the urban school has indicated that through the school's participation in the TEEM project, she has seen the benefits of using technology to support instruction and is willing to pledge any financial support needed to make the extended project successful.

The CD was introduced into CEE education courses at the conclusion of the project, ensuring that the project can continue at a different level. Developing a CD for inservice use and as a reference has provided inservice teachers with a tool for both introduction to and refinement of integration of technology into K-12 curriculum. We are confident that what was begun in this project will continue with the core teachers taking a leadership role in their schools. This confidence calls for the question: What happened in this professional development project that evokes such a strong statement of success?

Situating Constructionism

Teacher participants were encouraged from the beginning to take ownership in the process of learning to use technology to support teaching and learning. "What do *you* need?" was a question teachers needed to answer frequently and at every workshop. Planning for the CD may have been the most difficult part of the project. A mock-up of what a CD might look like was presented several times in the first six months of the project, but teachers were responsible for the content and for how the CD would look and work. This involved several brainstorming sessions with both large and small groups to work through the process. Teacher participants were not comfortable with taking the lead on the direction or content. To facilitate this, a workshop was held to address change theory and stages of concern. When teacher participants realized the CD could be called a "work in progress" and that they could collaborate, each with individual talents contributing to the whole (as opposed to having to become an expert in all areas), references to the project became "our project" rather than "your project." At this point in the process, teachers began directing, forming work groups, and eventually, taking responsibility for the final product. But this change in role–with participants facilitating direction and process–did not come easy for the teachers or for the administrative staff.

Reflections on Constructionism in the TEEM Project

The TEEM project, on reflection, was about teachers constructing; construction of a CD, obviously, but also construction of knowledge in technology, teaching, and in changing roles. In developing the project, we tried to make a connection to important intellectual ideas and connections to the teachers' own personal interests and passions. The challenge was to make the important intellectual ideas–the ideas of technology and content integration and teachers-as-leaders–salient and accessible, so that the teachers could engage meaningfully with these ideas as they went about their work on the project. At the same time, we tried to provide enough flexibility so that the teachers could build their own personal experiences, which was met with resistance from the teachers and from me as the project director.

The TEEM teachers were held accountable for their learning and, in this, I encountered resistance. I needed to create a learning environment that was not only worthwhile for the teachers, but also for the funding agency. And, from my point of view, it had to be worthwhile for me. "Doing" the project had to be more than my directing with teachers following my directions. I had to find out what the teachers needed in their own classrooms and in their schools. Asking them didn't give me the answers–at least right away. "Tell us what you want" was their typical answer to my question "What do you need next?" To challenge and scaffold these teachers' reconstruction of understanding and reasoning, I needed to know their existing beliefs and how to guide the development of powerful concepts. How does one guide when the path is unclear, when the journey is one's first? As decentralized ideas spread through

the culture of schooling, there is a deep-seated resistance to such ideas. I used Resnick's (1996) illustration of flying geese and decentralized ideas to start our first session and I referred to this illustration throughout the project. "In trying to understand natural systems, people often assume that a "leader bird" guides the rest of the flock when, in fact, flocking patterns typically arise as a result of local interactions among the birds" (p. 168).

The visualization of a flock of geese flying in a V, not following a leader but participating in the flying process as individuals contributing to the organization, helped us as a group to explore this opportunity to practice decentralization. The geese in formation honk from behind to encourage others to keep up their speed. We talked often about the collaborative nature of this project and the need for peer "honking." The point was for me, the director and facilitator, to relinquish control of the learning experiences and to facilitate the teachers' efforts in creating a learning environment in which activities not only highlighted important project concepts, but also facilitated personal connections. I didn't want the participants to assume that since I was situated at the point of the V, that I was leading in the design of our process or in the direction of our final product. The lead goose changes position in the V, rotating back into the formation while another goose flies at the point position; The TEEM project was created for all participants to experience the lead goose position. When participants expressed doubt in taking this kind of leadership, we used the V analogy again: Each bird flaps its wings, creating an uplift for the bird immediately following. By flying in a V formation, we could get where we were going quicker and easier because we were traveling on the thrust of one another.

Several questions guided my thinking on designing this professional development endeavor. How might we most effectively engage in learning about and practicing these innovations? How might the strategies of inservice be different from the dominant perspective of workshop facilitator as conveyer and teachers as the receivers? Will the skills and knowledge acquired contribute to inservice teachers' ability to practice what they have learned? How does a facilitator create and support an issue-driven learning environment? Would this learning environment move from training (focusing on performance and observable actions) to learning (performance with understanding)? What type of support encourages implementation of a vision of constructionist learning for adults? Could I relinquish control as the perceived lead goose? Would the teachers interact successfully to construct the forward-moving V pattern or would they stall and form prettier and possibly easier flying letters–maybe an "X" flying in all directions or a "Q" with no apparent direction and a definite leader?

For the TEEM project, it seemed important that the workshops developed would foster a critical, yet comfortable risk-taking environment. What ensued was chaos, a two-year period of disequilibrium and confusion. Why would I want to create an environment built on chaos? With chaos, we can begin to question our beliefs and assumptions. Until we question what we believe, we

can't expect change. Change from what? Change to what? Without the confusion, pandemonium, or discord found in a chaotic environment, we are complacent, comfortable, and willing to keep things smooth–no, insistent on remaining a part of the calm, easygoing, the predictable. When a dimension of chaos was added to the project mix, we were off-balance. Being off-balance was uncomfortable and disconcerting. But with this lack of balance, participants and project staff began to ask questions.

- Why am I uncomfortable?
- What does the director want?
- Who am I to be a part of this?
- What do I need to do?
- Why do I need to?
- What is this vision?
- Why can't I share this vision?
- Do I want to share this vision?

With the questioning came an examination of the issues raised by the questions–issues of teachers as creators of integrated curriculum, facilitators of inservice, modelers of technology, and creators of a CD. These issues unsettled most of the participants, as it did me as the project director. Belenky, Clinchy, Goldberger, and Tarule (1986, pp. 217-218) suggest that our task as educators is to be "midwife teachers" who help students give "birth to their own ideas, in making their own knowledge explicit and elaborating it." This is the closest analogy I can use to describe the disequilibrium and chaos that kept teacher participants ready to drop the project one minute and which resulted in a euphoria of "getting it right" in another. This "birthing" process (which eventually resulted in a beautiful 6 oz. CD) took every ounce of negotiation and understanding of the change process I could muster–as I lived what Prawat and Floden (1994) call the "constructivist dilemma."

> Striking the right balance between honoring the individual student's own effort after meaning while steering the group toward some 'intellectually honest' construction of meaning has been described as the 'constructivist dilemma.' It is one of the most vexing issues faced by teachers. (p. 48)

My own constructivist dilemma involved striking that balance between letting participants struggle with new leadership expectations–of providing their own direction for the project and the CD-ROM content–and with my own need to take control and make decisions without participant input. There were many occasions while in TEEM staff meetings that I grappled with and voiced the idea of giving in, of laying out the direction and the substance of a product. It seemed so easy to choose that direction. I was smack in the middle of the dilemma and it was an uncomfortable and frustrating place to be.

Finally, I had to say to participants in a number of different ways and over time, "I give you permission not to know everything, not to be a perfectionist, not to succeed, or not to understand fully." Participants (and myself) were encouraged to "come to know." Since I viewed learning as constructing understanding, my role as the teacher/facilitator changed from conveyer to scaffold. I entered the project as a learner as well. We were uncomfortable with questions about issues, process, and direction that extended beyond the workshops and lacked closure (e.g., "What if our lessons aren't quality?" "What if we don't have a CD ready by the end of the project?" "What if the participants don't accept the lead?"). We addressed these concerns in the following ways: we would insert a statement on the CD that stated our intentions and asked for feedback from users. We acknowledged that this CD was a work in progress with untested lessons (with accompanying directions on how users could provide feedback). We acknowledged that the *process* was important for the participants, the director, and the funding agency. If a CD was not ready by the end, we would address the reasons in a final report and we would learn from the doing. And what if participants wouldn't accept the responsibility for taking the lead? Then I would find out why. I would ask them and hope to learn more about facilitating a constructionist learning environment with inservice teachers.

Results of the Journey and Process: Teachers' Words

One participant summed up the second quarter of the project particularly succinctly. This journal reflection came after a particularly difficult time, from my point of view; a quarter of ups and downs with teacher participation, requests to drop out of the project, discussions about the change process when teachers wanted to spend time in front of computers, and an intensive two-and-one-half week seminar.

> My perceptions of a teacher-led process over the last 2 1/2 weeks has gone through several stages of transformation, kind of like an insect going through the stages of metamorphosis. When we started I wanted Dr. Gunn to give us all wee little assignments and tell us exactly what we should be doing. Instead we were treated as professionals and given the license to do what we were best at doing.
>
> At first, this process was frustrating to me. I wasn't sure where my place was in this process. However, within a few days the group seemed to have fallen into step with one another and we were off and running. Lesson plans were being developed by individuals, and being edited by peers. We were putting ideas on the table and pulling our resources together to develop a curriculum for this project. I felt like we became an interactive team, pulling in the same direction to reach our goal.
>
> I don't remember anyone saying to me, you do this! Instead, we all seemed to work well together and that made us productive. Allowing this to be a teacher-led process was scary at first, however

at the end of the 2-1/2 weeks it feels gratifying and empowering. This is an experience I want to bring into my classroom for my students. (Participant Journal, June, 1996)

The turning point in my own understanding of my role as facilitator came during the third day of this two-and-one-half week seminar, when I found myself wandering, unneeded, and even in the way of progress. Several groups of teachers were working around a set of tables in the computer lab–Project Headquarters, where group meetings took place–most with laptop computers they had scrounged from me and from acquaintances. They were using their laptops to keep notes and to write curriculum. Just seeing the array of computers around the table was gratifying–many of these teachers had very little experience with using computers before they entered the project. Occasionally I would see teachers move over to a computer in the U-shaped lab formation to access information on the Web. The teachers had divided themselves into grade level groups and were writing together, collaborating, and negotiating. They made lists of needs: specific information from the Web or a URL address; a scanned picture; the need for a picture to be taken with the digital camera. They gave this list to a technical team–a team of teacher participants who had determined they fit best in the technical realm of the project. Once the participants began leading the process, they also divided themselves into teams according to interest levels. The technical team worked in a nearby building where they were observed in a high-tech media lab locating resources on the Web, scanning pictures, taking trips out in the community to take pictures, creating computer-generated art work, and programming a prototype for the CD-ROM product. The two teams–the curriculum team and the technical team–made demands on each other and on me. At the end of each half-day session, they regrouped and handed each other assignments for the next session. At the end of each day, they used continua charts on the meeting room wall to indicate their group progress for the day. I found myself more times than not, in my office, staring at my computer screen and wondering what I had forgotten to do. In reality, the V was formed and was flying steady.

A Discussion on Constructionism and Managing Change in Professional Development

But what does this all mean, first to me as a professional development facilitator and educator in higher education, and then to readers who may hope to take with them a message that will have made a difference in some way to their thinking or practice? I think the message lies in the meaning I've made of the words "instructionism" and "constructionism." Papert (1993) tried to tell me this over and over again as I read his book *The Children's Machine*. I must not have been listening because it's been there all this time and it finally took root as I struggled through the TEEM project and with a concurrent teaching experience described in another chapter of this monograph (see Tucker & Gunn). Papert believes *instructionism* to mean something different from *pedagogy*, or the art of teaching. He describes it at an ideological or

programmatic level as "expressing the belief that the route to better learning must be the improvement of instruction" (p. 139). That was the message I had been getting throughout my career as a K-12 teacher and, later, as a professional development facilitator and college of education professor. If there is a problem with my class or student learning, I can fix it by teaching better. If there is a problem with School, let's fix it by producing better teachers. My vision of school reform weighs heavily on instructionism. My experiences with the TEEM project and a graduate level Interactive Instructional TV (IITV) course has forced me to look at Papert's ideas around instructionism and constructionism in a different light.

Papert (1993) tells us that with constructionism, the goal is to teach in such a way as to produce the most learning for the least teaching. He cautions that this doesn't mean teaching with less quantity of teaching leaving everything else hanging. Instead, constructionism should follow from the African proverb, "If a man is hungry you can give him a fish, but it is better to give him a line and teach him to catch fish himself" (p. 139). Taking the parable to the next step, learners will do best by "fishing," that is, finding for themselves the specific knowledge they need to get more knowledge. We have created dependent students, students who rely on teachers for answers, for directions, for taking the responsibility to teach them. In my own classes and inservice workshops, I have been the control keeper, the one who determines just about everything that happens in the "learning environments" I created, and students learned despite my efforts. On some level we probably all recognize the level of engagement it takes us personally to gain knowledge and understanding. We will have trouble, or not, with or without the confines of School. Papert reminds me about the "accepted wisdom that comes from knowing you can learn without being taught and often learn best when taught least . . . and the question for educators is whether we can work with this natural learning process rather than against it" (p. 141).

Let's use the TEEM project to work through the instructionism and constructionism philosophies. As the director of this two-year project, I had a vision of teacher participants developing a product that would help them make changes in their classrooms and in other classrooms in their districts. I admit that the word "reform" had a great deal to do with my writing the grant and in the way I wrote the steps for action. I had a hunch that the use of telecommunications and multimedia would help make a difference (the hunch partly based on the requirements of the proposal guidelines). I envisioned that at the end of the project, students would be more motivated to learn, more engaged in the learning process, and would be better educated individuals as a result. To measure the success at this level was not in the purview of this project, so I can't say whether we were successful at the level of better educated K-12 students. Because this was a professional development project, we could and did find out about teachers using technology in their teaching. But to get there, I had to alter my process for working with inservice teachers. In past workshops I've been involved in, the kind of "sit and git" (Imig, 1995)

workshops that we all know and have been participants of, the goals are usually developed for the teachers, as are the content and activities of the workshop experience. Somehow, without Papert's guiding words, I hit on a process of engaging teachers and moved into the realm of constructionism without realizing it. It is only on reflection that I have come to understand what really happened and why.

Papert (1993) reminds me that it is not the failure of School but the "success of the people who had developed their own methods for solving such problems–not what School failed to convey to them but what they constructed for themselves" (p. 142). It wasn't the workshops of the past that had failed these teachers. They just hadn't had the opportunities to construct for themselves this new knowledge of how to use technology. The TEEM teachers had to set their own goals for this project as well. There would be very little success in a project that I dreamed up and produced. I didn't read and keep close to me Papert's ideas for constructionism–that was to come after the project was completed. I didn't even consciously think about why I felt it was important for the participants to be the constructors of their own goals, process, and direction. I just knew my own development through years of "instructionism" had brought me to this juncture where I needed to hand over the reins, the control. And it was the most difficult and exhilarating thing I've done as a teacher/inservice facilitator.

The TEEM project took on a public and social construction when I relinquished control as director. Again I turn to Papert (1993) to help explain what happened when I ceased being the conveyer of information:

> The construction that takes place "in the head" often happens especially felicitously when it is supported by construction of a more public sort "in the world"... what I mean by 'in the world' is that the product can be shown, discussed, examined, probed, and admired. It is out there. (p. 142)

The TEEM project was "out there" in the sense that teachers were forced (and if asked, I am sure they would use words that elicit the idea of force: pushed, shoved) to assume leading roles that required them to ask questions about methods, materials, belief systems, and process. Constructivists believe that all individuals are engaged in creating a vast array of intellectual structures that give order to the world in which they live, and that these structures must support increasing levels of complexity. Constructionist thinking adds to the constructivist viewpoint. Where constructivism casts the subject as an active builder and argues against passive models of learning and development, constructionism places a critical emphasis on particular constructions of the learner which are external, shared, and meaningful (Gunn & Tucker, 1997). Distributed constructionism extends constructionist theory and recognizes that cognition and intelligence are not properties of an individual person but rather arise from interactions of a person with the surrounding environment–especially

other people (for more discussion on distributed constructionism, see Tucker and Gunn, this monograph). I believe the TEEM project became a successful learning enterprise because of the social, distributed construction that took place.

I've moved away a bit from the original theme of this monograph of developing learning environments supported by technology. If we believe that technology is a tool, it doesn't matter what kind of learning environment I've been describing here. The technology was not central to this project, it was a vehicle to support the teaching and learning process. What I think the technology did in this particular project, was to help create the chaos that was necessary for making change–change in our exhilarating experience. Flying in our V formation felt just right.

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BUILDING COMMUNITIES OF LEARNERS IN TECHNOLOGY-MEDIATED CLASSES: STRATEGIES THAT PROMOTE CONFIDENCE, PROBLEM-SOLVING, AND CRITICAL THINKING

Elizabeth M. Willis and Laura Sujo de Montes

This paper discusses two classes taught at New Mexico State University (NMSU), Spring 1997: an on-campus technology class and a distance learning technology class using real-time audio and video. First we describe the class contexts, then we present strategies utilized in building the learning environment in both classes, and, finally, we share candid evaluative comments by students and instructors about their class experiences.

Historical Background

Distance Education

Distance education, coupled with new technologies, is now breaking down the learning barriers of time and place, cost and effectiveness, in worldwide educational environments, universities, community colleges, school systems, and corporations (Thach, 1994). According to Valcke and Thorpe (1995), "distance education is the provision of learning opportunities which may be pursued by learners at sites (such as their homes or workplace) geographically removed from their tutors and the providing institution" (p. 112).

With the advancement of electronic equipment, synchronous learning has evolved. In the synchronous learning model, instructor and learners interact at the same time being separated by distance, but not by time, and although we have accumulated knowledge about individuals' interactions face-to-face in real-time (Comeaux, 1995), we know considerably less about the communication between students and teachers who are separated by distance but able to interact through audio and video technology at real-time speeds (McHenry & Bozik, 1995). Studies have repeatedly found that distance education achieves similar results in learning when compared to traditional teaching methods (Thach, 1994), but researchers now agree that studies of distance education should focus on a broader context than merely measuring learning, including building electronic educational communities, cooperative, collaborative learning, and team problem-solving (Harrison, Seeman, Behm, Saba, Molise, & Williams, 1991). Little research has been done on the impact of the recently introduced interactive distance learning networks on students' learning and perceptions or on alternative instructional strategies for this mode of delivery (Comeaux, 1995).

Educational Technology

Computer use in the classroom and computer literacy of teachers is improving, but cannot be said to be widespread. And, even though there has been an explosion in the design and creation of instructional software, significant numbers of teachers resist the day-to-day integration of computers (Willis, 1995). The dynamic nature of the information age continues to invent

intelligent technologies and strategies as quickly as the maturing fields of cognition and learning reveal new "learner systems" and processes of knowledge acquisition. Opportunities and needs are therefore expanding for the professional development of educators in order for them to recognize and utilize these tools and informational representations effectively in the classroom (Brooks, 1993).

Two models for incorporating technology into teacher education are described in this paper: (a) Integrating it into the on-campus college curriculum with professors modeling its use and learning activities centering around the use of computer technology, and (b) providing similar educational experiences through distance education graduate-level courses from colleges and universities.

Subjects and Settings

The Distance Learning Setting

EDUC 501 was a graduate-level, 15-week class, Educational Uses of Computers, taught to 30 inservice teachers at two distant learning sites located in Texas school districts about 60 and 120 miles, respectively, from New Mexico State University, Las Cruces, New Mexico. The two sites for EDUC 501 were Americas High School (AHS) and Socorro Independent School District (SISD) in El Paso, Texas, and Dell City, Texas. The instructors transmitted the class from an Interactive Television (ITV) classroom in the Business Complex at NMSU. The equipment allowed for two-way interactive video and audio exchange between two or more sites. Delay in image and audio was minimal at both the transmitting and receiving sites (Miller, McKenna, & Ramsey, 1993) permitting an active interaction similar in time to the one in a face-to-face class. When the instructors transmitted to AHS and Dell City, there was not another class present at the ITV classroom.

AHS had 24 Macintosh computers distributed in three rows with the screens facing the back wall, which was a window wall. When students were working at their computers, they were facing the front wall from which the ITV camera was hanging. There were two TV monitors in front of the room, one to see the instructor and the other to see the other remote site. Space between rows was limited which rendered group work difficult. The Dell City setting had five IBM-compatible computers because only five teachers were taking the class at that site. Computers were distributed in two rows, one with two and the other with three computers. The camera was set at the front of the room and the instructor could see all the students from the camera home shot. The distance education class met Monday evenings from 4:00 to 7:00 p.m.

The On-Campus Setting

EDUC 568 was a similar 16-week on-campus class, Educational Uses of Computers, with 18 preservice/inservice teachers earning advanced degrees at the NMSU main campus. The setting for the face-to-face class (on-campus) was the Learning Resource Center (LRC) in the Department of Curriculum and Instruction at NMSU.

The laboratory in the LRC had 24 Macintosh computers spaced around three walls of the room with the monitors against the walls. When students sat at the computers, they had their backs facing the center of the room. At the center of the room there were three tables placed one against the other. At the right side corner nearest to the front of the classroom, the display computer for the instructor was on a movable cart. The display computer used an LCD panel on top of an overhead projector. The overhead projected the computer screen image onto a big screen at the front of the room. When the instructor demonstrated a lesson, the students turned away from their computer monitors and faced the front of the room. There was enough space between the computers and the center tables for group work. The on-campus class met Wednesday evenings from 7:00 to 9:30.

These two courses were both taught during the Spring 1997 semester, but were not taught simultaneously. However, contact hours, graduate credit, on-line communication, syllabi, readings, and collaborative projects were the same for both groups. In order to determine how the differing conditions, on-campus and at a distance, may have influenced content learning as well as student/student and student/instructor interactions, we interviewed selected students face-to-face, and regularly e-mailed questions about the course, environment, and instructors to all the students.

Content And Strategies

EDUC 501 and EDUC 568 were both graduate level technology classes with students to receive 3 credit hours toward a Master's degree in education at NMSU, so it was important that the two courses offer the same content. The students worked in very different environments, but experienced virtually the same teaching/learning strategies and, in fact, reported similar feelings and thoughts about the robustness of the course work and the value of their interactions with instructors and each other. Both experienced a variety of collaborative, cooperative strategies, the goal of which was building a community of learners within each class, a community who could ultimately use each other as resources during the course and upon its completion. Let us take a closer look, from both the instructors' and students' perspectives, into the classrooms and examine, in some detail, the strategies that were used.

Constructivism in EDUC 501 and EDUC 568

The instructional framework for these classes stemmed from constructivist thinking based on ideas from John Dewey, Lev Vygotsky, Jean Piaget, and Jerome Bruner. The characteristics of the constructivist model include (a) the construction of knowledge by the learners, rather than receiving it from all-knowing teachers; (b) cooperative, collaborative work, rather than only individual; and (c) a focus on problem-solving, rather than sequential skill-learning (Robyler, Edwards, & Havreluk, 1997). Neiderhauser and Stoddart (1994) suggest that "constructivist" teachers believe that computers can assist students in constructing knowledge; teachers with a more behavioristic approach believe that computers are teaching machines.

Learning environments should foster personal meaning-making and discourse among communities of learners (Jonassen, Davidson, Collins, Campbell, & Haag, 1995). Construction of knowledge, then, shifts from being individually constructed to socially constructed. While the educational research community has by no means reached consensus on the best way to educate our children, a large part of that community has in recent years converged on a core set of pedagogic principles that form the basis of the constructivist paradigm (Report to the President, March 1997, p. 33).

Classroom Strategies for Building Confidence and a Community of Learners

In many traditional classrooms, students are asked to stand and introduce themselves to classmates at the beginning of the semester as a way to "break the ice" in getting students to know each other. From personal experience we have found this one-to-many introduction is often uncomfortable and "scary" for students in an already anxious technology environment. So, in these two classes students used a biopoetry form to interview, then introduce, each other. The poetry form is free form with blanks for such information as first name, sibling of . . . , lover of . . . , who fears . . . , etc., ending with last name. Students interviewed each other, learning bits and pieces of biographical and other meaningful information, visiting, laughing, and chatting as they completed the form. Each was then asked to introduce the other, not themselves, using the biopoem as the basis for the introduction. This strategy immediately set the tone of the class: personal, supportive, and relaxed.

As follow-up to this group activity, students were invited to send a brief biographical sketch to the instructor using electronic mail (email). This strategy introduced students to email technology in a non-threatening way–all they had to do was talk about themselves. And, further, when they received an answer back within a day, it reinforced the idea that this was a class in which one was not just a number, but a person with an important life outside of the educational setting. Although this seemed particularly important when students and teachers were separated by distance, as the off-campus class was, it is appropriate for any classroom in which educators want to maintain open communication with students.

In an interview with a group of the on-campus students about the class, they said the professor was "very understanding, helpful, patient, and supportive." In addition, they reported feeling her as a close person, not as an unreachable class figure.

From that first short autobiography, the use of email continued to be an important informal link between instructors and students and student to student, further supporting the "community" concept introduced with the biopoetry activity. For instance, when a party was in the works at the off-campus site, students planned the details through email. They even shared recipes following the get-together.

Subject: Re: Party
I'm glad you liked the avocado (sic) dip. I will gladly share this easy recipe with you.
Ingredients:
1 lb. of cottage cheese(depending on how much you want to make)
4-5 large avacados (you can add of delete avacados depending on your taste and how much you need to make)
Long green-stem onions (diced)
4-5 jalepenos (raw, diced)
salt (to taste)
Mix all ingredients with a spoon or fork. I usually do the avacados first then put in the cottage cheese and finally the onions and jalepenos.
All done!! Enjoy
I hope this is an o.k. explanation of how to make the dip. If not, let me know on Monday.
See you soon.

Another student shared her thoughts as the class came to a close, demonstrating the kind of relationships built throughout the semester.

Subject: Re: Yippee!
I will miss you. I hope to have the opportunity to take further courses like yours. I truly appreciate your instruction, patience, consideration and friendship. In spite of glitches and tech problems, you always maintained a sense of humor and consideration for our needs. It made the problems easier to bear. Thanks again for a great learning opportunity.

Carrying through with the personal, community tone set by the instructors, another introductory activity involved students designing and creating a personal sign to introduce them to the graphics application Print Shop Deluxe. Following a brief demonstration of the application, students "played" with the program, designing and redesigning a sign that they felt made a statement about themselves. Learners in both classes used a variety of the available graphics, from a football and golf clubs, to cookouts and exotic scenes. Through this very personalized, individual activity, students again felt their importance in the class as they created an artifact about themselves. In addition, they taught themselves and each other about the application, Print Shop Deluxe, in a non-judgmental atmosphere where there was no "right" or "wrong" answer or exact way to complete the project.

Within three weeks students were reasonably comfortable with their technology environments and each other, and both classes were introduced to the long-term, cooperative learning project for the semester, THE LECTURE SERIES.

Classroom Strategies for Critical Thinking and Problem-Solving

THE LECTURE SERIES is an example of a student/instructor and student/student learning contract. A scenario is introduced in which the class is divided into small, collaborative groups of students (3-5) who are invited to plan a lecture series which will include such personalities as famous scientists, mathematicians, authors, musicians, political scientists, composers, and/or artists. Individual students within each group have the opportunity, then, to investigate their personality of choice which will then become part of the group's LECTURE SERIES. Selection, research, and work is individual; the final product and presentation is collaborative. Students "become" planners, sharing their individual knowledge, learning about an area of personal interest, and, participating in a strategy which they can take directly into their own classrooms. An example of publicity for the Lecture Series follows.

PUBLIC AFFAIRS OFFICE
New Mexico State University

January 20, 1997

Dear Content Area Experts:

Thank you for agreeing to plan, advertise, and report on the newly-instituted 1997 NMSU Lecture Series. NMSU has budgeted a series of six lectures in the content areas. We have selected six titles and a lecturer from each should be included. They are:

- Famous Authors and Their Vision
- Famous Mathematicians and Their Mathematics
- Famous Scientists and Their Theories
- Famous Political Leaders and Their Social Contributions
- Famous Artists and Their Paintings
- Famous Composers and Their Music

From you, we request for the lecture series:

- An advertising flyer for each of the lecturers
- A press release for each of the lecturers
- A HyperStudio presentation to be used to promote the lecture series—3 individual cards for each, linked as a group presentation
- A newsletter presenting a brief summary about each of the lecturers
- A database of 10 families or businesses to whom you will send advertising
- A spreadsheet of Lecture Series expenses

Again, thank you for planning these NMSU events and for preparing the material that will make them possible.

Sincerely,
Liz PubAff, Director, NMSU Public Affairs

Within the framework of THE LECTURE SERIES content, the technology learning is embedded: word processing, graphics, database, spreadsheet, and

multimedia. Research skills are also learned and practiced, not only using CD-ROM encyclopedias and library articles and books, but also through Internet access on the World Wide Web (WWW).

Students began the design process by meeting in their groups to decide individual research topics that would fit into a LECTURE SERIES theme that the group decided on, such as FAMOUS WOMEN IN HISTORY or THE FIRST MULTICULTURAL LECTURE SERIES. For the next seven to eight weeks, class was devoted to creation of the artifacts that became THE LECTURE SERIES presentations: advertising signs, newsletters, databases for mailings, spreadsheets of expenses, and, finally, multimedia presentations about the lecturers. Successful completion of the project meant that students worked individually and interacted in groups; they learned to coordinate time frames, integrate information, communicate with each other and the larger group, and share knowledge. What each individual learned became part of the small group's knowledge, and, finally, was integrated into the whole class's knowledge. Individual construction of knowledge became the social construction of knowledge by the class; it was not only the individual's acquisition, but also a part of the context in which it was created.

According to Jonassen et al. (1995), a constructivist environment engages learners in collaborative activities in a meaningful context where they have the opportunity to reflect on what has been learned by conversing with others. The result of the interaction is a community of learners who have shared the knowledge-building experience. Jost (1995) sees the importance of a community of learners as promoting active knowledge construction, encouraging students in assuming a more responsible role in their own learning, supporting the development of collaborative decision-making and problem solving, and aiding in the promotion of metacognitive skills. One of the most valuable outcomes of THE LECTURE SERIES project was precisely this: the construction of a community of learners.

Reported Student Perceptions

To aid us in "getting at" this notion of the student-teacher and student-student interaction, this community of learners, and how it takes shape in an educational environment, especially under the two very different conditions reported here, throughout the course a number of inquiries were emailed to students in both classes about their perceptions of class interactions, learning, and instructor evaluation. Student responses were sent to the doctoral student who co-taught the class and were shared with the instructor only after the semester ended. Included here are the students' own words about their perceptions of the learning environments created on- and off-campus:

> (1) What I like about this class. The instructors. Both . . . are excellent. I especially want to thank . . . for staying with me and helping me complete a card. I know that it caused her to be late for an appointment, but she insisted on staying until I was satisfied with the product. What

was amazing was that I ran into . . . accidentely (sic), almost as I was looking for help. But she took it upon herself to make time to go to the learning center and work with me. This activity was repeated when I again ran into the instructor, next day, and she also stayed with me and helped me complete my next two cards. Again, it was a case where she also went out of her way to assist me. However, these two activities demonstrate to me the professionalism and dedication that these two individuals have. I find it refreshing to find it at the university level where too many of our professors are into the professor "trip." They forget that they are also teachers and find it difficult to combine the two. In . . . , we find a professor who is also a very good teacher. It is a rare find on a University campus and has helped me tremendously in my efforts to become computer literate. I am not there yet, but with her help I expect to get there before the semester is over.

What I do not like, or bothers me, about this class. I guess that what would help me is more step by step handouts of how to do things. I am from the old school and need to now (sic) a before I can do.

(2) What I like most about this class is that both (instructors) are "very" helpful with each student. They are able to give one on one attention to each student when needed. I never felt that any question I had was "silly." I like very much the attitude of "going through experiences to learn from the challenges we encounter." Also, the more experienced students in the class have been the utmost help to us beginners.

(3) What I like best about this class—I like the fact that everyone shares their knowledge. Its (sic) like an all for all atmosphere and to someone that is just learning the way around this tech., its (sic) great. I like the way that things are explained, so that you learn the terminology and then what it really means.

What I do not like—this class goes by so fast, that sometimes at 9:30 I feel that I need a little more time (mind set) but body set says no, no. So, I guess that I wish the class was at 6:00 instead of 7:00.

(4) What I like best about this class. . .
I like that we are responsible for our own learning. It's nice to have peers there to help us when we get stuck. I have learned alot from this class and enjoy it very much. One thing I have really enjoyed is how relaxed (the instructors) make us feel. The due dates are flexible which is nice when we are trying to hold down a job and a family and class at the same time. I don't feel all stressed out and am able to enjoy the class and what I am learning.

What I don't like about this class...
I don't know if there is anything that I don't really like. I would much rather see you in person to ask questions than have to talk to a microphone. I guess because I'm not use (sic) to doing that.

(5) There are several things I like about the class.
The hands on approach is the only way to learn about computers. Also I like working in groups with people from other schools who are much more knowledgeable than I and who don't hesitate to share their knowledge. In addition to helpful classmates, (she) has been a wonderful teacher who always treats us as her equal.

The dislikes are few. Not having a teacher in the classroom is a disadvantage. Although it makes the student become more responsible for their learning. Overall, I have enjoyed the class.

According to Jamie Sawatzky in the September, 1997, ASCD Education Update, "Teachers should create a classroom where the exchange of ideas is encouraged, respect for all students and their work is fostered, and a sense of community is established" (p. 4). In EDUC 501 (off-campus ITV) and EDUC 568 (on-campus) just this kind of learning environment was planned and established, as demonstrated by reported student perceptions and it worked, both off- and on-campus.

Instructors' Perceptions And Reflections

We believe we reached the goal of creating a community of learners in both classes, but the process was not without challenges, particularly at the distant site. This was the first ITV course either of us had taught, so much of our reporting is colored by inexperience with the delivery medium, and our perceptions may indeed have changed with another opportunity to teach the same class. EDUC 501 (the ITV, off-campus class) had a fair share of hookup glitches; there were even two classes we finally had to tell the students good-bye because the connections were so "iffy." We tried to remain calm, and, in fact, it seems we were so successful that students reported later that they took their cues from us and simply carried on without us. We recommend that an operator/aide be continuously available during class times at distant sites not necessarily for student assistance (they were able to help themselves), but to field technical difficulties.

We all learned to deal with the technology difficulties. This was a particularly good lesson for us, the instructors, who were accustomed to relatively problem-free technology classes. Staying in touch through email became a strong element of support between classes for the off-campus group.

The distant students reported that not having an instructor in the classroom at their site was a disadvantage, and we felt the disadvantage of not being in

the room keenly too. However, we all realized what an advantage it was for them not to have to come on campus or for us to go there every week. They came to rely on each other, becoming truly cooperative, because they had to. And many of those same ITV students went on to take another distance class the following semester.

We felt we "knew" these students just as well as those in the on-campus class and agree that our e-mail communications probably aided us in this. We also had taken Polaroid pictures of them and tacked the photos on a board we kept at our transmission site so that we could refer to it. We visited the distant site three times throughout the semester and were able to visit face-to-face as if we "saw" them every week; we knew names and faces and something about them as real people from their biopoetry and email autobiographies!

EDUC 568 (the on-campus environment) had its own challenges, though they were not connection kinds of things. In that class was a group of Indonesian educators who not only had never worked in a Macintosh computer environment, but who also had limited English-speaking experience. We all had a wonderful time teaching each other language and technology; traditional English-speaking students became expert translators for all kinds of concepts. That group of educators gave us a real sense of diversity issues, and the whole class grew in unplanned ways as we grappled with explanations of technology and strategies.

As a result of our experiences with these two classes, which were offered in such diverse environments, we concluded that the student-centered, instructional strategies and cooperative, collaborative settings gave essentially the same experiences to the students, no matter where they took place. Student survey responses indicated that both environments yielded similar learning and interaction outcomes.

But, there is another model we might have used–interclass collaboration. We wish that we had planned ways that the students in the two classes could have worked with each other, not just within each class. For instance, students might have used email or chat utilities to interview each other from one site to another. There could have been an interclass Lecture Series and discussion of the course readings with groups made up of students from both classes.

We also suggest that further investigation of student-student and student-instructor interaction should be done to determine more appropriate and effective strategies for collaboration and cooperative learning in both traditional and alternative course delivery systems (such as the ideas noted above). While these two classes demonstrated to us that confidence, critical thinking, and problem-solving skills in technology-based environments can be infused into both on-campus classes and classes at a distance through careful planning and use of cooperative strategies, we believe that we have much to understand about how learners perceive their learning and interact in various educational settings.

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Part II

New Technology Paradigms in Highly Technical Learning Environments

INSTRUCTIONAL STRATEGIES FOR DEVELOPING A TEACHING AND LEARNING TECHNOLOGY-BASED CURRICULUM

Glenda A. Gunter and Judy R. Lee

Introduction

Education is moving toward a global, technology-rich environment designed for an increasingly diverse population of students. This technology phenomenon has directly impacted higher education. Education programs, both graduate and undergraduate, are being revised and updated to include technology, higher education faculty are modeling technology in their classrooms, and students are learning with and about technology (Simonson & Thompson, 1997).

Integration of technology into the higher education curriculum has prompted a major upheaval within the learning process. The shift has moved from students acquiring knowledge in the conventional lecture-practice-recall method to engaging students in activities that allow them opportunities to construct knowledge. This emphasis on the learner is particularly appropriate for graduate students (Knapp & Glenn, 1996).

Two strategies showing great promise for graduate students are learner-centered and self-directed technology exercises, activities, and assignments. These strategies have proven meaningful to students in several ways (Jonassen, 1996).

- Individual and small group activities address different learning styles.
- Cooperative learning is encouraged.
- Cross-discipline learning is promoted.
- Higher-level thinking skills are used and developed.
- Class experiences are based on real-life experiences.

Graduate students in education are preparing themselves to become better teachers, media specialists, and technology coordinators. Colleges of Education have a responsibility to prepare these graduate students to succeed in a technology-rich environment. By providing technology-based courses and experiences in their training, graduate students can learn to develop innovative teaching techniques that use a variety of technologies (Poole, 1997).

This article will describe the restructuring of a graduate-level technology course. The design and development of the course will be explained, activities and assignments will be discussed, and challenges and solutions will be offered. The intent of this article is to share information, provide guidance for those considering the integration of technology into a course, and demonstrate an effective technology course.

Restructuring a Graduate Technology Course

Two faculty members in the College of Education at the University of Central Florida came together to restructure an existing technology course.

One faculty member is the Coordinator of the Master of Arts Educational Technology program. This program is designed to prepare teachers to become site-based technology coordinators in public schools. The other faculty member is the Coordinator of the Master of Education in Educational Media program. This program prepares teachers to become public school media specialists. While the curriculum in both programs is technology based, the Educational Media program examines emerging technologies as well as video, electronic cataloging, automated circulation systems, and electronic and print literature. The Educational Technology program provides an opportunity for teachers to learn to apply technological tools to the learning process, model professional technology training, demonstrate instructional design theories, and develop leadership skills in the implementation of technology into the school setting. The decision to bring the two groups together into one class was based on several reasons:

- Computer laboratories, equipment, and software were in short supply and constant demand.
- Combining the two classes considerably freed the limited technology resources.
- No one person can know everything.
- The expertise brought into the course by two faculty members was invaluable.
- Technology Coordinators and Media Specialists work closely in public schools.

This class gave the graduate students an opportunity to develop a collaborative attitude. Faculty wanted an opportunity to teach technology skills and content by modeling the technology. The philosophy was that if technology is integrated into effective teaching and learning practices, it could help restructure the curriculum and improve instruction (Knapp & Glenn, 1996). Adult learners need to learn to use technology in a non-threatening environment (Meltzer & Sherman, 1997). In order for graduate students to embrace technology, they need authentic hands-on exercises, time, access, support, and resources to acquire ability through experience. Students from both Master's programs are preparing themselves to assume a leadership role in public schools. Once teachers are hired as Media Specialists or Technology Coordinators in public schools, they are expected to promote technology, train teachers and students to use technology, and provide guidance for teachers in integrating technology into the classroom. Therefore, a major focus of the course was to provide opportunities for graduate students to learn to teach with technology, as well as how to use technology.

The course being restructured was EME 5051, Technologies of Instruction and Information Management, which is a foundation course for both programs. Students taking the course discussed various theories and practices utilizing instructional media and information technologies. A major emphasis of this

course was on new and emerging technologies and their effects on the school and media programs. The following objectives were identified for the course:

- The student will demonstrate the ability to operate and maintain equipment effectively and efficiently. The student will demonstrate the ability to select the most appropriate medium for a given situation.
- The student will identify effective methods for acquainting public school students with materials and motivating them to use appropriate media.
- The student will develop and conduct activities to acquaint teachers with existing media, new technologies, and the effective utilization of technology in the classroom to meet individual needs.
- The student will identify appropriate criteria for evaluating and selecting media and equipment for instruction and information management. The student will demonstrate leadership roles in the diffusion and adoption of innovations.
- The student will demonstrate knowledge of new and emerging technologies.
- The student will identify various communications and instructional design models, evaluate them, and relate them to classroom learning situations.
- The student will develop instructional methods to enhance students' reading, listening, viewing, and production skills.
- The student will read and evaluate current research articles about technology in public schools.

Designing and Developing the Course

Planning of the course began with a series of meetings between the two faculty members. Each faculty member was an equal partner and contributed to the design, development, implementation, and management of the course. The course is a survey course; therefore, the goal was to present an overview of current technology topics. These topics were then integrated throughout the curriculum of both programs. Considerable time was spent discussing and selecting the latest and most relevant technology topics to include during the semester.

Since the course is only taught once a year, the content has to be revised and updated on a regular basis. Available resources were examined and evaluated for currency. Close attention was given to outdated equipment and software, as well as the ever changing Internet and World Wide Web (WWW). Due to the phenomenal growth of the WWW, Web sites disappear as quickly as they appear. Faculty spent time at the beginning and throughout the semester planning and developing strategies to address these factors.

The central theme for the course was the use of the WWW to establish communication and connectivity and to explore information opportunities and challenges. This thread ran throughout the course and created the framework

for designing assignments and activities, as well as group and individual projects.

In the design process, the faculty kept one question in mind: What do students need to know to be successful Technology Coordinators and Media Specialists? The most frequent answer was to provide these graduate students an opportunity to use technology to explore, acquire, gather, and evaluate information. Of equal importance was the ability to access information through search strategies on the Web and evaluate the use of information found on the Web. Furthermore, students needed to learn how to determine appropriate uses of information and how to evaluate electronic resources using the Web as a tool. In addition, strategies were developed to help students acquire sophisticated research skills.

The delivery method for instruction was a combination of lecture, demonstration, laboratory experiences, small group activities, individual activities, tutorials, guest speakers, and peer teaching. Hands-on, practical experiences were provided with each technology being introduced in the class. Special consideration was given to developing class experiences to address students' diverse learning styles and skill levels, and to provide various learning approaches to the content.

The class met once a week in the evening from 5:15 p.m. to 8:15 p.m. in an electronic classroom. This classroom was equipped with a Mac and PC computer connected to the Internet and the WWW, overhead projection system, VCR, audio, ELMO (a desktop presenter and document camera), and adjustable lighting. Two computer laboratories equipped with Macs and PCs with connectivity to the Internet and the WWW for all students were also scheduled for designated class nights. The following calendar and topics to be taught was developed:

August	Introductions, Syllabus Netscape: Introduction
September	Searching the Web Instructional Design: ASSURE Instructional Design Model Web Based Instruction What's New in Technology Using E-Mail Workshop
October	Evaluating Web-Based Electronic Effectiveness Introduction to Multimedia: PowerPoint Advanced Techniques with PowerPoint Ed Tech Teaching: Copyright/Ethics Ed Media Teaching: Acceptable Use Policy Ed Media/Ed Tech Planning Session

November	Safe Computing Assistive Technology Collaborative Teaching: Educational Media
December	Collaborative Teaching: Educational Technology

Assignments and Activities

Students completed a skills assessment survey on the first night of class. This survey was designed to identify individual student's technology skill levels and created a baseline for developing instructional strategies. It also helped identify students who would be peer tutors or peer coaches on a particular subject. A diverse list of software, hardware, and related technologies were included in the skill survey. Students evaluated their technology skills level using a scale that ranged from "comfortable using" to "never used before."

Both the Media Specialist and Technology Coordinator work closely in a public school setting. Therefore, opportunities were provided throughout the course for these two groups to interact with each other. The faculty felt this course provided an excellent format for developing a collaborative team approach to learning and teaching. By developing activities and assignments that fostered collaboration, students learned to comfortably communicate and work together.

Students started the course with an introduction to Netscape Communicator. This was followed by a lesson on developing search strategies, using search engines and Boolean logic. Students were then shown several evaluative tools designed to assess and evaluate the design and content of information found on the Web. The final part of this extended lesson involved sending students to various distance education sites and letting them write reflective evaluations of their Web experiences.

Another assignment involved having students visit various web sites and evaluating each resource by design and content criteria. Unlike print materials, WWW resources need to be evaluated more carefully. Educational Media and Educational Technology students need to be trained in evaluating effectiveness of the use of the World Wide Web and to be able to train other teachers on evaluation techniques. Moreover, another useful strategy was to send graduate students to various distance education sites and let the students compose reflections of their experiences. The students took great interest and pride in writing their reflective evaluations. Students enjoyed the opportunity to reflect and create their own learning experiences. By creating paths through the Web sites, students were constructing their own learning experiences by discovery learning. Students felt they were in charge of their learning process and, through their reflections, felt a strong kinship to this evaluation process.

All topics, assignments, and activities were designed and developed to prepare students for the final Collaborative Teaching experience. By the end of the semester students had developed a collaborative spirit, mastered the necessary technology skills, understood the importance of Instructional Design,

and had overcome their initial technology fears. They were ready to use technology to teach a technology-related lesson. The Collaborative Teaching experience combined peer teaching and personal experiences between Educational Technology and Educational Media students. In other words, each group taught a lesson using technology. Topics for the teaching experience were determined based on individual program needs.

The Collaborative Teaching topic for Educational Technology students was Copyright and Ethics which evolved from topics in another class they were taking during the semester. The class involved discussions in copyright and ethics as applied to the school setting with areas of interest in telecommunications, use of the Internet, software copyright issues, and Fair Use Laws. Educational Media students were preparing policies and procedures manuals for their media centers in another class. Their Collaborative Teaching topic, Acceptable Use Policies, evolved from that assignment. This cross-course approach was useful for developing continuity across programs and classes.

The process for the teaching assignment involved pairing an Educational Technology student with an Educational Media student. Each student provided one-on-one instruction to their partner on their designated topic. Using the ASSURE Instructional Design Model (Heinick, Molenda, Russell, & Smnaldnio, 1996) as their planning tool, students analyzed their learners' needs and developed a lesson providing the appropriate level of information, activities, and teaching.

Students in both programs revealed their thoughts about this assignment on their evaluations. One student stated, "I enjoyed working with my collaborative teacher, we both learned a lot and developed a rapport that will keep us in touch with one another." Most comments read like this: "The semester assignments and activities have prepared us for collaborative teaching. Thank you for providing so many hands-on activities. I learned a great deal from the collaborative teaching. What a great opportunity!" This collaborative learning was intended to actively engage the student in the learning process and was organized to improve the student's critical thinking, reasoning, and problem-solving skills. The following is the assignment sheet provided for each Collaborative Teaching team.

You will teach your partner a 30-45 minute lesson on_____. To do this, you will need to complete the following:

1. ASSURE Instructional Design Model used to design and prepare the lesson
2. A PowerPoint presentation
3. A backup lesson (thumbnail sketches, note page, or outline)
4. A handout developed to support the lesson

Steps in this assignment:

1. Conduct an informal interview by talking with your partner to find out how much he/she knows about the topic

2. Plan your lesson using the ASSURE Instructional Design Model
3. Gather information about your topic from the Web and other appropriate resources
4. Decide what you want to include in your PowerPoint presentation about your topic
5. Produce the PowerPoint presentation
6. Develop a handout and backup
7. Practice your lesson . . . make it last 30-45 minutes

Miscellaneous Information

1. Your PowerPoint presentation should be long enough to present the information about your topic
2. You should have a title slide that includes your name(s) and a "The End" slide
3. You will turn in:
   (A) a disk with the PowerPoint presentation
   (B) a copy of the handout and backup
   (C) a copy of the completed ASSURE Instructional Design Model
4. Your grade will be based on the following:
   ASSURE Instructional Design Model
   PowerPoint presentation
   Handout
   Backup
   Teaching
5. Your partner student will evaluate your teaching, the PowerPoint presentation and the handout
6. You will have 30-45 minutes to teach your lesson
7. You will teach in the lab classroom
8. Be prepared . . . practice!

Challenges and Solutions

Combining the Educational Technology students with the Educational Media students resulted in a class size of 51. Managing a graduate technology class this size presented several challenges. First, seven hands-on, in-class and out-of-class assignments were developed to correspond to each technology topic. Grading and maintaining accurate records was time-consuming for the number of students and the number of in-class and out-of-class assignments.

Locating a classroom or computer laboratory in the College of Education that would accommodate these numbers was often difficult. Room assignments were made well in advance of the scheduled class to insure adequate teaching space. Additionally, all class materials and handouts had to be developed by the professors. Because of the nature of the class and the continual need to update materials, a current textbook could not be found that addressed all areas. Course content was provided through handouts, web sites, and assigned readings.

The faculty met regularly to share concerns, observations, and recommendations in an attempt to identify and record indicators of success of the course. Planning and flexibility are prerequisites for teaching this type of course. Adjustments, modifications, and changes to assignments, activities, teaching strategies, and technology were made as needed. All revisions were noted and used for final evaluation of the course. Students at the end of the semester used formative evaluation procedures to identify effective strategies for teaching and learning with technology.

Conclusion

Colleges of Education must provide students with supportive educational experiences in the successful use of technology. Graduate students must be encouraged and inspired with a variety of innovative teaching and learning strategies.

Formal evaluation by students indicated the course was successful and most students enjoyed the course. When the students were asked to describe the things they liked most about the course, the following comments were given: "The interaction and cooperative learning with our classmates, the constant feedback between instructors and students, being given the chance to reason and to explore, and the hands-on experiences with technology." The faculty felt collaboration between Educational Technology students and Educational Media students enhanced student learning in this course.

Higher education faculty also must have opportunities to explore and develop relevant, useful curriculum. The restructuring of this graduate technology course provided a window of opportunity for faculty to model effective uses of technology in the classroom. Faculty were forced to rethink instruction and to apply innovative strategies demonstrating appropriate uses of various technologies. Their role with students shifted to that of facilitator, mentor, coach, and resource.

By developing instructional strategies that maintain a high quality, technology-based learning environment and by empowering graduate students through authentic technology learning experiences, the learning environment extends beyond the higher education classroom. The best way higher education can promote the use of technology is to provide training for teachers. This training will prepare teachers to integrate technology into their individual curriculums and to be leaders in the adoption of technology in public schools.

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JOURNEY THROUGH THE CANYON: A REVIEW OF THE DESIGN STRATEGIES OF THE GRAND CANYON CD-ROM

Gary R. Tucker

History of the CD-ROM

Northern Arizona University's Educational Systems Programming (ESP) in partnership with Oklahoma State University was a recipient of a grant award of the United States Department of Education's Star Schools program for 1994-96. With support from the Star Schools Grant and in partnership with the Grand Canyon National Park and Grand Canyon Association, ESP produced Geonauts, a distance learning program of environmental and earth science for grades 4-6. The Geonauts instructional program included: the Geonauts television program which was broadcast on The Learning Channel in Fall 1996 and an interactive multimedia CD-ROM on the history of the earth using The Grand Canyon as a context. The project goal was to develop the CD-ROM using the Grand Canyon as a context upon which to build an interactive, multimedia enrichment to complement the Geonauts television program. The design was based on constructivist learning theory.

The Learning Goals

The conceptual understandings or learning goals of the Grand Canyon CD-ROM (hereafter referred to as the CD) are three-fold. First, using the Grand Canyon as a context, a goal is for students interacting with the CD to begin the process of constructing an understanding that the earth is very old. The Grand Canyon is an excellent focus for this because the exposed rock layers, faults, and evidence of geological activity within the Canyon provide superb evidence to support current theories of geological time. A second learning goal is for students to construct an understanding that there are forces acting upon the earth that cause the surface to change drastically over time. There is probably no other place on earth that provides evidence for this conclusion like the Grand Canyon and the Colorado Plateau upon which the Canyon sits. The final learning goal of the CD is to allow students to add to their prior knowledge that environments and the living organisms of those environments, like the Canyon and the surrounding Plateau, have changed with time. The fossil record found in the sedimentary layers of the Grand Canyon and the surrounding Colorado Plateau provide some of the richest evidence for this concept.

Design and Learning

Design and learning have not always been viewed as closely connected. Theories of design and learning have very different origins (Kafai & Resnick, 1996). Designers have been interested in the final product concentrating on the process and the complexities that influence the design of that final product. Learning theorists are primarily concerned about the process of learning, not the products. "Recently, however, theories of learning and design have begun to move toward one another. Both design theorists and learning theorists now

view "construction of meaning" as a core process" (Kafai & Resnick, 1996, p. 4).

There is a convergence of the fields of design and learning with an emphasis on creating quality learning environments through design. In this view, design involves building a relationship between the learner and the product. To accomplish this, designers must have a clear understanding of the learning goals of the product, an understanding of theories of how quality learning environments are created, and a sound foundation in content. The focus is to provide a process by which the user constructs meaning from having experienced the interaction between themselves and the designed product. A primary challenge of effective design is to use a context to fuse learning objectives into a coherent unity based upon current theories of how we learn.

Learning Theories

The Constructivist learning theory is supported by a long body of literature and research (Dewey, 1938; Piaget & Inhelder, 1971; Bruner, 1971; Noddings, 1990; Gardner, 1991; Brooks & Brooks, 1993). The Constructivist perspective contends that knowledge is the result of individual constructions made by the learner. These constructions that result in understandings about one's world are active, mind engaging processes. Information must be acted upon in order to have meaning for the learner. The constructivist theoretical framework views the learner as a builder of knowledge; not a passive receptor, but an active constructor.

In the 1960s, Seymour Papert and his colleagues initiated a research project dedicated to the study of how children think and learn, especially in highly technical environments. A theoretical framework has evolved from this work and has become known as *constuctionism*. Constructionism is both a theory of learning and a strategy for education, especially about the roles for technology in learning.

> We understand 'constructionism' as including, but going beyond, what Piaget would call 'constructivism.' The word with the 'v' expresses the theory that knowledge is built by the learner, not supplied by teachers. The word with the 'n' expresses the further idea that this happens especially felicitously when the learner is engaged in the construction of something external or at least shareable. . . . This leads to a model using a cycle of internalization of what is outside, then externalization of what is inside and so on. (Papert, 1990, p. 3)

Constructionism shares one of the main tenets of constructivism in that learners actively construct knowledge, but it goes beyond theory and places special emphasis on the knowledge construction that takes place when learners are engaged in construction of something external that can be shown, discussed, examined, probed, and admired (Papert, 1980, 1993). While both models cast

the subject as an active builder and argues against passive models of learning and development, constructionism places a critical emphasis on particular constructions of the learner which are external, shared, and meaningful.

The Design

The design of the Grand Canyon CD is based upon the tenets of constructivism and constructionism. Brooks and Brooks (1993) identify five guiding principles when trying to establish a constructivist classroom. These guiding principles provide a foundation that allows the translation of theoretical concepts of constructivism into the reality of the multimedia design of the CD. To this was added some of the basic principles of constructionism: learners are most likely to become intellectually engaged when they are working on activities that are meaningful. Much of this "meaningfulness" comes from the learner being able to construct something external that they can share and exhibit to be admired by others (Papert, 1980, 1990; Kafai and Resnick, 1996).

Structuring curriculum around primary concepts is a critical dimension of constructivist pedagogy noted by Brooks and Brooks (1993). Constructivist teaching practices help learners internalize and reshape, or transform, new information. Students are most engaged when problems are presented holistically rather than in separate, isolated parts. When concepts are presented as wholes, many students seek to make meaning by breaking down the wholes into parts they can see and understand. To allow the students to focus on large ideas, the interactive multimedia of the CD was designed so students can assume the role of a scientist as a member of a team of scientists floating down the Colorado River, making stops at six sites within the Grand Canyon (Figure 1). Each "scientist" is to collect data along their river trip in an attempt to construct an understanding of a problem that is presented to them in a holistic manner before they begin their trip. A structural geologist is collecting data to facilitate an understanding of geological time in an attempt to gain a better understanding of how old the earth really is. The second scientist, the geomorphologist, gathers information on erosion and the rock cycle using the context of the Canyon to construct an understanding of how forces cause the surface of the Earth to change over time. The final scientist on the team, the paleontologist, studies the fossils and sedimentary layers of the Canyon, in order to construct an understanding of how environments and living things within those environments change with time. Allowing each student to choose a role and providing a certain freedom of movement through the CD by using the power of hypertext, will help address the issue of meaningfulness, which is a vital part of the constructionist paradigm.

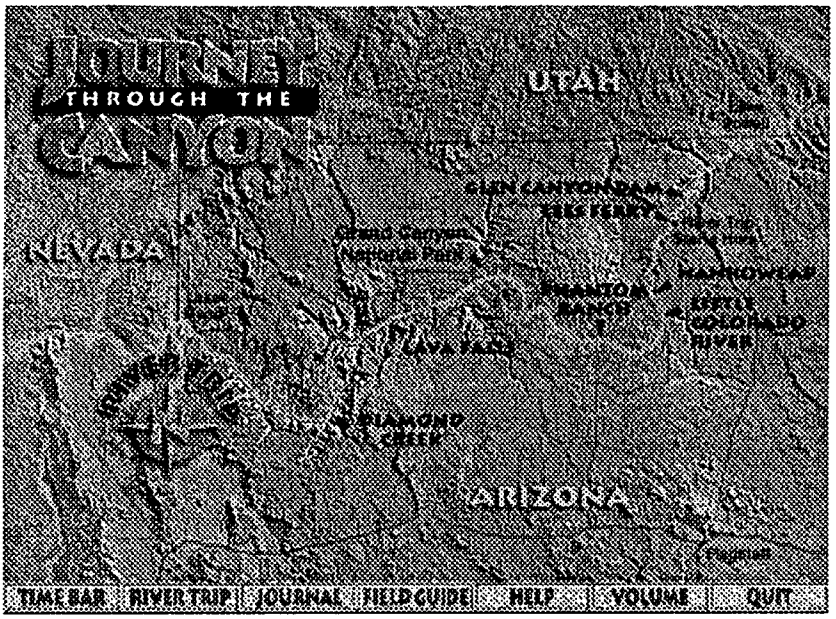

Figure 1. *The central menu of the Grand Canyon CD-ROM illustrates the six stops of the river trip. This menu is the main navigational page that allows users to visit a site as needed.*

The goals of constructivist teaching practices are to help learners internalize and reshape, or transform, new information creating new understandings (Brooks & Brooks, 1993). Before new understandings can be facilitated, existing understandings must be uncovered. The ability to uncover students' existing conceptions is, to a large degree, a function of the questions and problems posed to them. The facilitation of new understandings is a function of how they internalize the answers to those problems. Brooks and Brooks (1993) maintain that in order to gain an awareness of present understandings of students and to facilitate internalization of new information, it is crucial to avoid isolating the variables for the students or give them more information than they need or want. Also, it is important not to simplify the complexity of a problem prematurely. The CD provides guide questions for every scientist at each stop along the river (Figure 2). Each guide question was designed to direct the students toward predictions and to allow the students to begin to piece together the conceptual understandings or learning goals of the CD. Careful attention was given to allow the students to explore using the interactive multimedia capabilities of the CD while ensuring that the design did not isolate variables or simplify the complexity too early. To test their predictions and to assist them in creating new understandings, students are directed to an electronic Field Guide that contains content information presented in a multimedia, hypertext environment (Figure 3). Because of its hypertext design, once students are in the Field Guide they can access information from many different perspectives and are responsible for determining the amount and types of

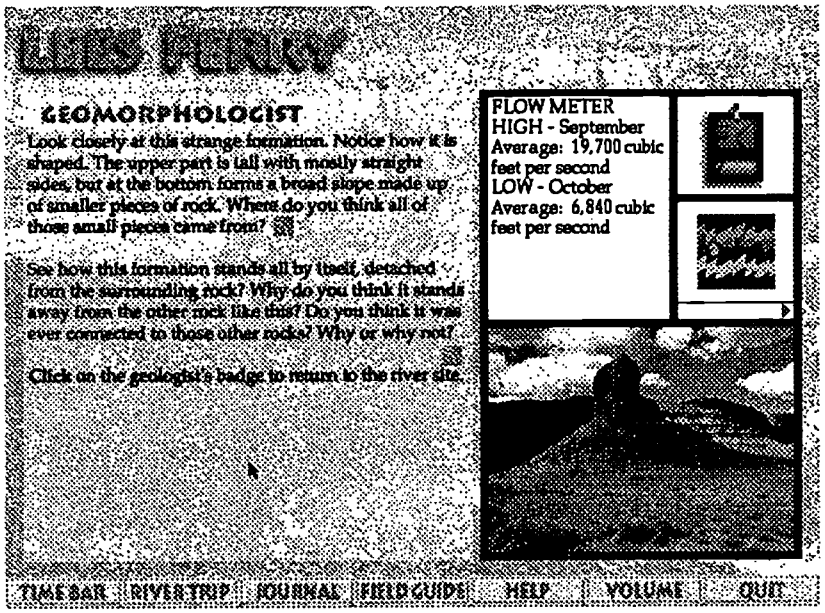

Figure 2. *An example of a guide question for one of the scientists, the Geomorphologist, at Lee's Ferry. The guide questions are designed to direct the students toward predictions and allow the student to begin to piece together the conceptual understandings or learning goals of the CD.*

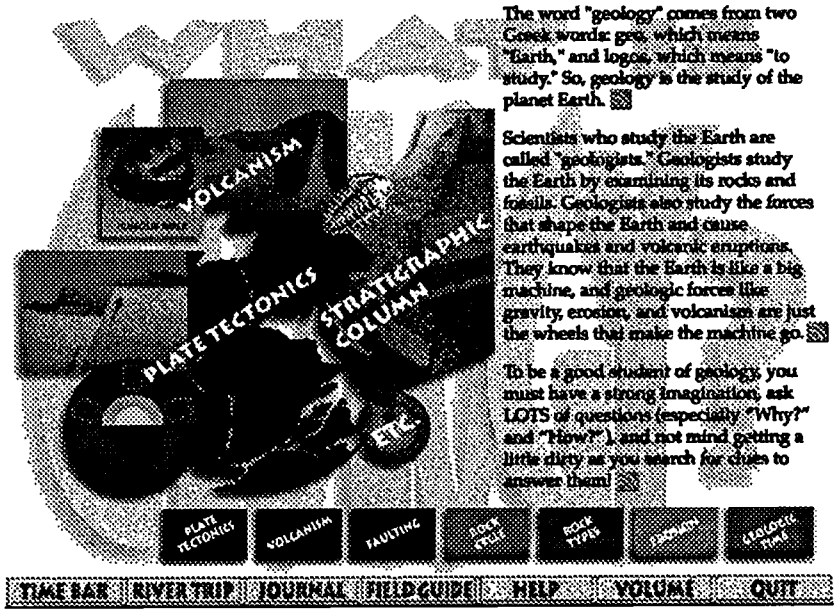

Figure 3. *The menu for the geology section of the Field Guide contains content information presented in a multimedia, hypertext environment. Due to its hypertext design, the students can access information from many different perspectives and it is the student who determines the amount of information they need and want.*

It is important not to impose adult expectations on a child's thought processes, but rather, to look at the child's behavior as a manifestation of movement to an ensuing way of reasoning (Brooks & Brooks, 1993). A child's errors are natural steps to understanding (Labinowicz, 1980). Educators do not know what ideas students possess or what new ideas are within their reach unless something specific is done to find out. Student suppositions can often be understood by the avenues they choose to accomplish specific tasks and by the nature of the questions posed by them while engaged in these tasks. The CD allows the teacher opportunities to gain insights into students' suppositions by the creation of a Personal Journal (Figure 4).

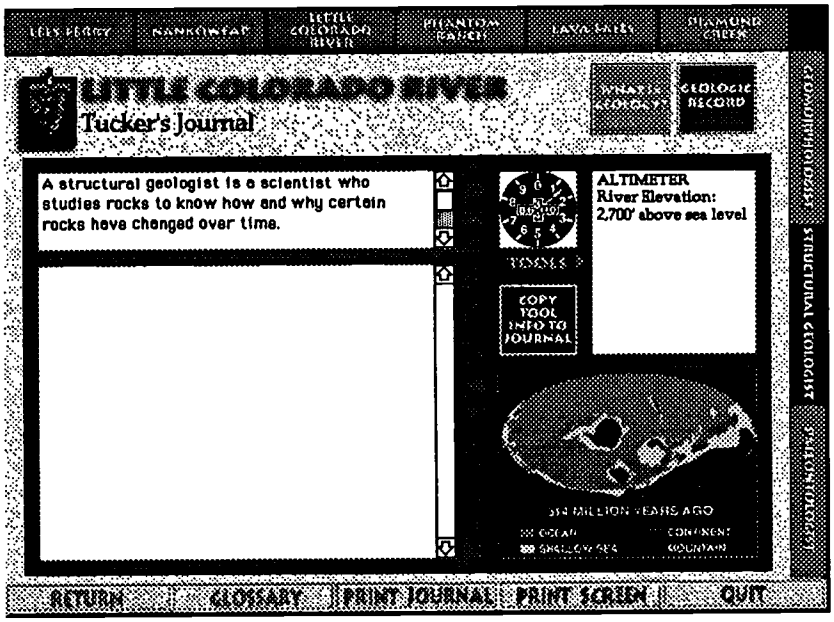

Figure 4. *An example of one page from the Personal Journal of the Structural Geologist for the Little Colorado River site. The Personal Journal provides a place for the students to keep notes, collect images, collect data from virtual tools, and transfer content information they feel is important from the field guide in the process of searching for the answers to the guide questions.*

The Personal Journal provides a place for students to keep notes, collect images, and collect data from virtual tools. It also is a place in which to transfer important content information obtained from the field guide in the process of searching for answers to the guide questions. In the students' attempt to record their understandings, the journal becomes an evolving entity. The CD creates a file on the hard-drive that stores this information under each student's ID so that the information is retained even if the student takes several attempts to complete the river trip. The teacher can access the journal externally from the CD and examine it at anytime. Allowing a teacher to access the journal as the river trip progresses assists the teacher in assuming the role of a facilitator, one who guides students toward constructing accurate conceptions. If at any

time within the process the students and/or teacher feel the teams are lacking information, the CD allows them to return to the river and revisit a site to place additional information into their journal.

Constructivist teaching practices are designed to help learners internalize new information. But, assessing another person's understanding is often an ambiguous endeavor. The process of internalization of understandings escapes concise description and resists the assignment of a numeric value. As Brooks and Brooks (1993) pointed out, we see neither the internalization nor the process of construction, making it exceptionally difficult to assess. It is perhaps the constructionist paradigm that may provide a key to assessment. Constructionism presents not only a theory of learning, but also presents a strategy for education (Kafai & Resnick, 1996). Assessment of learning takes on the form of not what students can repeat, but what they can generate, demonstrate, and exhibit.

> Children don't get ideas; they *make* ideas. Moreover, constructionism suggests that learners are particularly likely to make ideas when they are actively engaged in making some type of external artifact . . . which they can reflect upon and share with others. Thus, constructionism involves two intertwined types of construction: the construction of knowledge in the context of building personally meaningful artifacts. (Kafai & Resnick, 1996, p. 1)

Based upon this principle, the CD provides a two-fold opportunity for the students as a team of scientists to construct an "external artifact." The first of these opportunities is the construction of the Personal Journal that has been previously discussed (Figure 4). The Personal Journal is produced by the individual and shared primarily with the teacher; furthermore, it is shared with the other members of the team as the river trip unfolds.

At the conclusion of the river trip the concept of production of an external artifact evolves when students must construct a learning product called the "Big Book." (Figure 5). This learning product is an exhibit that represents a biography of the earth. This biography has three chapters. Chapter One demonstrates how the positions of the earth's land forms have changed over time, Chapter Two demonstrates how the surfaces of these lands have changed over time, and Chapter Three demonstrates how the earth's environments and life forms have changed over time. In creating this product, the students are free to place in the chapters any information they have collected in their journals, any information they may have from outside resources, and any original work they have created which helps them demonstrate and exhibit their understanding of how these changes have occurred over time. Instructions in the Teacher's Guide encourage the teacher to make the production of the Big Book an event such as an open house for parents or students from lower grades. This process provides the opportunity for students to create a product "in the world" that can be shown, discussed, examined, probed, and admired (Papert, 1980, 1993).

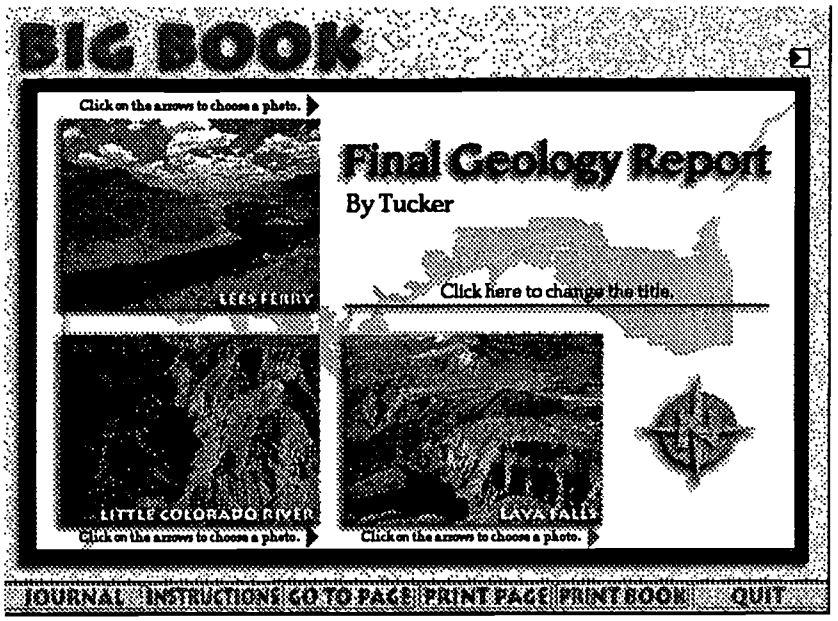

Figure 5. *The initial page of the learning product is called the "Big Book." This learning product is an exhibit that is to represent a biography of the earth. The students are free to place in the chapters any information they have collected in their journals, any information they may have from outside resources, and any original work they have created.*

Conclusion

The purpose of this article was to provide a conversation about the design of the Grand Canyon CD-ROM and the theoretical educational foundations that formed the reasoning behind that design. The design should facilitate learners in their attempt to construct arrays of intellectual structures that provide an understanding of the learning goals. How successful the design is in accomplishing this goal is yet to be determined. The CD is in the process of being Beta tested with 4th and 5th graders in the public schools as this article is being written. As with any complex task, such as in the production of this multimedia CD, there are aspects we would change if we had the opportunity to go back and redesign. There were some components of the CD that were conceptually simple, but, in the translation of those concepts, we were limited by the constraints of our technology. We anxiously await the results of our field tests and hope we will have the ability to translate those results and the knowledge of our experiences into a significant educational product with the production of "Journey Through the Canyon," version 1.0.

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Acknowledgments

The production of something as complex as the Grand Canyon CD-ROM is a team effort. Without the leadership and direction of Dr. Samuel J. Levy, the Geonauts instructional program including the Geonauts television program and the interactive multimedia CD would never have happened. I am grateful to Laurel Strong and Margo Folsom who were the tireless "code-warriors" that made the CD design a reality. A special thanks goes to Donna Weberg Natale whose artistic skills took something as grandiose as the Grand Canyon and made it come alive in a digital form. Finally, to Lauren McFall, thank you for taking my words and skillfully translating them into conversations that have meaning for children.

A CONSTRUCTIVIST PERSPECTIVE ON DISTANCE LEARNING

Kathleen P. Glascott and Sandra J. Stone

Defined as a general category of technological alternatives for learning delivery systems, distance learning attempts to unite instructors and students over space and time (Truman, 1997; Sherry, 1996), increasing the potential for access to higher education. For this discussion, distance learning refers to the use of interactive instructional television (IITV) where the instructor and students based in the university classroom have the technological support to interact with university students at distant sites. The university classroom and distant sites both have television monitors and individual microphones which provide immediate visual and auditory access. In addition, a camera pad is present at the originating site allowing the instructor to share printed materials (i.e., transparencies, texts, slides, in-class handwritten notes) with all sites. Television monitors are also connected to an on-site computer allowing for information to be presented on screen. Through interactive television, the university instructor is enabled by technology to deliver a university course to on- and off-campus students located at different sites, and interact with *all* students in the course. The number of distance sites may vary from a few to many (usually five to seven). The number of students on- and off-campus may also vary from a few to 20 or more.

While the technology is relatively new, distance learning has advanced from just a delivery system of university courses over television to interactive instructional television. Yet the question of pedagogy still remains an issue. Considering the technological constraints, is constructivist pedagogy a viable method of learning for IITV students in education methods courses, or have the new interactive advances created real potential for quality constructivist education through distance learning? In addition, what are the issues surrounding IITV with respect to class size, timing, instruction, scheduling, and community?

The Behaviorist Instructional Paradigm

First, it is important to examine the behaviorist paradigm of instruction for it is this paradigm that has dominated the field of education for years and is easily accommodated by IITV.

Behaviorism (Skinner, 1953) suggests that the majority of human behaviors are motivated by positive and negative events. Positive and negative consequences shape behavioral expectations. Thus, all behaviors shaped by external forces can be subsequently quantified. In the behaviorist view of teaching, the instructor transmits knowledge to the student. Teaching strategies are scientifically applied and learner outcomes are assessed.

For example, a lesson is sequentially planned with behavioral objectives which identify the end product and help the teacher remain focused on the lesson. The objectives also enable "the teacher to plan precisely the steps leading to the end behavior" (Jacobsen, Eggen, & Kauchak, 1989, p. 113), and to

assess the students' performance in terms of the specified objective(s). The lesson includes what you want to teach (content) and how you intend to teach (strategies). The procedure is the set of directions on how to present the lesson and the evaluation component must be consistent with the behavioral objectives.

Madeline Hunter's (1982) popular approach to instruction is an example of a contemporary behaviorist model. Hunter's model presents precise steps for the lesson planning and delivery. Elements of behaviorist's models most often include teacher-directed lesson presentations, curriculum-centered lessons and evaluation, guided practice of new material, checking students' understanding of the content, reteaching, and graded evaluations.

Philosophically, this approach is described by Elkind (1989) as psychometric. Learning is "governed by a set of principles (e.g., intermittent reinforcement)" and consists of the "acquisition of a set of skills (e.g., decoding) that are independent of the content to be learned" (p. 114). In addition, knowledge is something that can be acquired and measured independently from the processes of acquisition. The goal of psychometric education is to produce individuals "who score high on tests of achievement . . . in other words, . . . to maximize the acquisition of quantifiable knowledge and skills" (p. 115-116). Basically, knowledge is transmitted, students acquire the knowledge, and the acquisition is appraised through tests.

Indeed, in the years before interactive instructional television, the behaviorist's model of transmission really was the only viable model for distance learning. Content was transmitted via the instructor through the television medium, and students received the content transmitted, taking notes of important data. The goal of "maximizing the acquisition of quantifiable knowledge and skills" was evaluated through testing the objectives of the course content. Within the behaviorist paradigm, success was determined not by genuine understanding, but by a student's ability to replicate the curriculum. According to Hirschbuhl, Jackson, and Bishop (1995), a problem in distance learning is that the delivery system still represents behaviorist classroom settings.

There is no doubt that the current distance technology enables the behaviorist model to function successfully. The instructor can transmit knowledge via IITV to all students, on- and off-site. The pad camera and computer programs create excellent and polished delivery of content. The instructor can now check students' understanding of the content as it is delivered, and students are able to respond and ask questions regarding the content. It is a very workable model.

Constructivist Learning Paradigm

Constructivism takes a different philosophical stance. While behaviorism is interpreted as a theory of teaching, constructivisim is regarded as a theory of knowledge and learning (Brooks & Brooks, 1993). Learning from a constructivist perspective is grounded within the writings of Piaget (1963) which emphasize the active participation of the learner. Integral to the

constructivist perspective is the understanding that the learner is not a passive recipient of knowledge. That is, knowledge may not be transmitted directly through instruction. The learner personally constructs his or her own knowledge. In the constructivist model, students are responsible for their personal construction of knowledge through the dynamics of authentic experience and dialogue (Glascott & Stone, 1997).

Piaget (1963) uses the word schema to describe the mental structure by which a person intellectually adapts to and organizes the environment (Wadsworth, 1989). Assimilation is the cognitive process by which a person integrates new information into existing schemata, and accommodation is the process of modifying an existing schema so the new information will fit into it or creating a new schema for the new information. Foreman (1993) notes that people arrange facts in particular ways to generate relationships which create systems of *meaning*.

Constructivists believe the relationships that connect facts and provide coherency in a mental system may not be *transmitted* to students. Rather, students construct understanding for themselves (Foreman, 1993). Brooks and Brooks (1993) interpret this process as making sense of our world by

> synthesizing new experiences into what we have previously come to understand . . . . When confronted with . . . discrepant data or perceptions, we either interpret what we see to conform to our present set of rules for explaining and ordering our world, or we generate a new set of rules that better accounts for what we perceive to be occurring. Either way, our perceptions and rules are constantly engaged in a grand dance that shapes our understandings. (p. 4)

The interactions of the person with his environment and the person's reflections on those interactions lead to structural changes in thinking (Brooks & Brooks, 1993). Knowledge, then, comes from neither the subject nor the object, but from the unity of the two (Piaget & Inhelder, 1971).

Elements of constructivist learning models include instructor as facilitator of learning, person-centered curriculum, process learning, social learning, meaningful and relevant experiences, autonomous learners, and authentic assessments with no need for grades. Elkind (1989) describes constructivist learning as a developmental philosophy of education where the conception of learning is a creative or constructive process. He reiterates that "knowledge is always a construction, inevitably reflecting the joint contributions of the subject and the object. . . . Knowledge is thus always a construction of the mind's interaction with the world and cannot be reduced to one or the other" (p. 114-115). Elkind sees the goal of constructivist education as facilitating the personal construction of knowledge and "to produce thinkers who are creative and critical" (p. 115).

With a focus on learning as a personal construction, rather than on teaching curriculum, the constructivist instructor clearly designs learning differently from the behaviorist instructor. With the focus on the learner, the instructor

creates learning environments in which students are encouraged to explore, think, discover, and invent their own understandings of the world (Foreman, 1993).

According to Brooks and Brooks (1993), there are five overlying principles of constructivist pedagogy including (a) posing problems of emergent relevance to learners, (b) structuring learning around "big ideas" or primary concepts, (c) seeking and valuing students' points of view, (d) adapting curriculum to support students' suppositions, and (e) assessing student learning in the context of learning (p. viii).

Student autonomy is also a critical component. Students are encouraged to look to themselves to organize, understand, and find their own problems. As Brooks and Brooks (1993) note, the instructor's main task is to help students "clarify for themselves the nature of their own questions, to pose their questions in terms they can pursue, and to interpret the results in light of other knowledge they have generated" (p. 30).

Keeping in mind that real learning occurs only when the students are actively engaged in meaningful, relevant experiences and in dialogue with others, constructivist methodologies must include hands-on learning experiences, cooperative social learning, and assessment made within the contexts of the experiences.

IITV and Constructivism

Distance technology provides a new challenge for constructivist pedagogy, and changing to a constructivist paradigm is surrounded by multiple issues. Constructivist instructors contend that hands-on experiences are more difficult to facilitate across multiple sites. Technological parameters often limit cooperative social learning, and authentic assessment within the contexts of IITV learning is very difficult (Glascott & Stone, 1997). Research also indicates that media instruction takes longer to prepare (Walsh, 1995). Without technological and administrative support, constructivist faculty may be reluctant to design and interact with distance education.

Yet, new technology has literally opened doors of possibility for constructivist learning. Constructivist instructors are finding they can pose problems of relevance to learners, structure learning around "big ideas" or primary concepts, seek and value students' points of view, and adapt curriculum to support students' suppositions via IITV (Brooks & Brooks, 1993). By providing relevant and meaningful classroom experiences within the context of social learning, instructors can engage students in mental and oral discourse which leads to reflection on those interactions and, subsequently, to structural changes in thinking. Instructors can encourage students to be responsible for their personal construction of knowledge through the dynamics of experience and dialogue on IITV (Glascott & Stone, 1997).

For example, in a constructivist IITV class, the instructor invites the dialogue surrounding instructional models. Students at all sites are able to reflect and respond through their individual microphones to the questions posed

and content explored. Social learning is encouraged on site through small discussion groups. Distance sites also may dialogue in small groups. In the case where there is only one or two students at each site, the microphones may be turned off in the originating site and the two or three sites with small numbers are connected so they can become one discussion group. Outside of class time, e-mail pairs and chat rooms are also a useful way to increase the dialogue.

When relevant materials are delivered at the beginning of the course to all sites, every student in the course is able to use the instructional materials within the class time, engaging and reflecting on the process. Other meaningful experiences can also be connected to the class by providing guided practicum experiences in local schools outside of class time, where students may practice using constructivist instructional methodologies. These authentic experiences are designed and organized by the instructor, so students can personally interact with the processes and children in order to build their own knowledge of how to facilitate student learning. Authentic practice is authentic practice whether it takes place in the traditional university classroom, within the local schools, or via distance technology.

With the sole responsibility for the construction of knowledge placed in the students' hands, the formation of knowledge constructs will be uniquely individual. Students may explore and handle similar materials or have similar experiences, but ownership of the knowledge generated from within the individual students will be theirs alone.

Reflections on authentic experiences may be both written and oral. These personal experiences guide and enlighten the class curriculum through discussion, and the instructor has the opportunity to facilitate the student's learning by responding to the reflections. Duckworth (1993), in describing her constructivist teaching, suggests her role is to observe and then ask what the learners understand rather than what she perceived should have been learned.

Within this type of constructivist methodology, the knowledge is not "transmitted" directly through instruction as a behaviorist model would do, rather the students truly have multiple opportunities to construct their own knowledge. Students who look to themselves are more likely to experience authentic cognitive conflict. As one student noted, "I enjoyed [this class] thoroughly and learned more on my own. A distance learning class offers the perfect opportunity to practice constructivism because the teacher is not always there to tell you what to do" (Glascott & Stone, 1997).

Even though constructivist learning can exist within the IITV framework, there are limitations that need to be addressed. In a study by Glascott and Stone (1997), university students participating in constructivist IITV education classes rated significantly higher what they learned with the instructor on site than those who were at distant sites. They were found to prefer the instructor being physically present in the class rather than via IITV. Students perceived that the student-teacher relationship did not have enough time to grow. Distance learning students also reported less opportunity to ask questions, fewer

conferences with the instructor, and less time to share projects. In addition, students indicated a desire for the instructors to visit sites more frequently. Technology provided access to instruction and experiences, but the distance between student and instructor inhibited individual responses and subsequent conferencing. In addition, immediate and personal feedback on assignments was difficult. High enrollment in distance learning across several sites also undermined one-on-one interviews. Furthermore, reflective pieces requiring instructor guidance were more difficult to respond to for the instructor. For example, a response journal with a workload of 25 students is difficult, but a workload of more than 75 students is impossible.

IITV instructors also report that it is more difficult to interact with individual students and small groups of students. The instructor does not have the luxury of listening in on the distant sites' group discussions as he does with group discussions on site (Glascott & Stone, 1997).

Even with these limitations, Glascott and Stone (1997) found that students rated constructivist pedagogy via IITV high (4 on a scale of 5). Even though they preferred the instructor to be present in the class, they still evaluated what they learned as high.

Recommendations for addressing some of the problems associated with facilitating constructivist pedagogy via IITV include scheduling additional class time on-line, so the instructor has the opportunity for individual and group discussion and conferences before the actual class time begins or ends. E-mail and chat rooms, while somewhat advantageous, do not allow for the face-to-face personal social engagement of learning.

FAX machines located at each site would facilitate more timely feedback on short written reflections and assignments. Large projects could be viewed and discussed with students during the before or after the regular class time allowance via IITV.

Continual reform in the delivery systems should be aggressively pursued in order to adequately address the issues of creating more interaction between the instructor and individual sites and site-to-site interaction without all sites having access visually or auditorily. Class time should be lengthened for distance classes in order to address the extra time it takes for students to participate in the dialogue.

Administrators have a critical role in scheduling distance learning sections. Not only is it the administrators' responsibility to ensure that an instructor is not unduly challenged with student enrollment numbers, but also that the number of sites is reasonable. In addition, reducing the number of classes taught by the instructor in order to give him or her more preparation time is helpful.

Furthermore, providing adequate support personnel and technology at sites can promote or diminish constructivist distance learning effectiveness. If students are limited to only a few microphones their ability to respond is restricted. This is not congruent with the constructivist process which invites and regards student interaction. Support personnel should also include

instructors who are able to accompany students to practicum experiences in the schools, facilitate the use of classroom materials, make assessments in the context of the experiences, and facilitate the timely delivery of assignments.

Conducting constructivist pedagogy effectively over IITV does not just depend on the strength or weakness of the technology, but also depends on the instructor. According to Sherry (1996) "the most important factor for successful distance learning is a caring, concerned, teacher who is confident, experienced, at ease with the equipment, uses the media creatively, and maintains a high level of interactivity with the students" (p. 5). Thach and Murphy (1994) also describe eight major knowledge areas for faculty needed for effective distance education including communication and feedback, ability to promote interaction between and among learners, teamwork and collaboration, administrative and support services, conduct learner needs assessments, understand distance learning and its impact on learners, identify learning styles, and develop a systems perspective of thinking (p. 16). All of the criteria identified as significant for effective distance education are also essential for constructivist pedagogy. Unless students believe they are respected and can relate with the instructor, learning is diminished. It will be the instructor, not the equipment, that promotes or undermines authentic experiences and student interaction. In other words, it will be the philosophical stance of the instructor that will structure learning opportunities and subsequently influence student learning.

Interactive instructional television is a viable reality for constructivist pedagogy in addition to enabling universities to serve greater student populations. However, evaluation and research of IITV delivery, increasing the fluidness of the technology, providing adequate support for constructivist instructors, and creatively using technology to facilitate student learning should be an on-going work which will free technology to be a tool rather than an obstacle for constructivist learning to occur.

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RETHINKING LEARNING ENVIRONMENTS: A TEAM INVESTIGATION OF BELIEFS AND PRACTICE

Gary R. Tucker and Cathy L. Gunn

Universities have been forced to do more in the way of instruction to distant learning sites with less and to do it better. In the case of Northern Arizona University (NAU), a mission to provide courses and programs across the state has led to the increase of alternative course delivery methods, including cable TV, interactive instructional TV (IITV), and World Wide Web-enhanced or Web-based courses. This movement into technology-related delivery results in a concern for the resulting learning environments.

> For any institution to adapt to new circumstances, judgments about purposes and priorities must be made. Making wise judgments in complex social institutions such as universities requires insight into the multiple components and relationships in these institutions. Often, the judgments that are made–for example, to increase the number of students per staff member or to make across-the-board cuts–appear not only counterintuitive but dangerous to the learning environment. The centrality of learning is lost in the exigency of expenditure reduction. (Donald, 1997, p. 1)

A university can become known for their response to the need for electronically distributed courses and in the process, pay little attention to the quality of the learning environments that result. In response to NAUs mission to provide courses to students at distant sites and to our personal mission to investigate technology-based distributed learning environments, the authors deconstructed and then reconstructed a doctoral-level foundations course, Contexts of Educational Technology, for IITV and Web delivery.

Defining Our Distributed Learning Environment

In this chapter, we share the course design and our intentions to create active and learner-centered environments supported by technology and the Internet. We present a description of the physical learning environment, an introduction to constructionism–the theoretical underpinnings and the basis for the course design, a presentation of the course as it played out, personal reflections and self-criticism from the team-teaching instructors/authors, and a discussion of how our experiences relate to larger issues in creating technology- and Internet-supported learning environments. First, we provide a description of the physical classrooms to give our readers a context for the course "Contexts of Educational Technology."

ECI 751 Course - Contexts of Educational Technology (Physical Setting)

The interactive instructional television (IITV) studio was located in the communication building on Northern Arizona University's (NAU) main campus (also called the "Mountain Campus"). Nine ECI 751 [course number] students arrived the first evening peeking in the door first to make sure this was really the place (note: while there were 10 enrolled at the Flagstaff site, one student completing an internship in Phoenix divided her time between the two sites). The classroom "on campus" didn't look like a typical classroom found in an education course (Figure 1). There were no desk/chairs aligned in the typical circle with a blackboard on one end. Instead, students found a small, dark, and crowded room with a large TV screen in a front corner next to a wall-mounted camera. Two more cameras were mounted on the back wall, with a television screen for instructor use. A traditional instructor podium was in the expected location–front and center, but next to it was a pad camera–a desktop camera that magnifies and displays anything a teacher would want all students to see in a close-up (e.g., a computer chip, a photograph). Three rows of long table spaces made up of three tables shoved together end-to-end, obviously provided student seating. At 3-foot intervals, goose-necked microphones raised their heads and gave a final indication that this classroom was not typical. A turquoise curtain provided a backdrop behind the podium or front wall, and a door, with a small rectangular window, led out of the left side of the room. A glance through the window showed a console of TV monitors, controls, telephone, video machines, fax machine, and an array of blinking lights. Jared, a student director, sat at the controls, typing on a keyboard with a telephone receiver tucked between ear and shoulder as he listened and occasionally spoke to a person on the other end.

The course Contexts of Educational Technology was about to begin and, to most students enrolled, it was a first foray into what NAU faculty/staff call distance learning, or an IITV course.

What students in the NAU Mountain Campus classroom did not see until exactly 4:30, the beginning time for the course, was a second classroom located at Valley Community College (identifying names other than NAU have been given a pseudonym) in a computer lab/ library building 150 miles from NAU's Mountain Campus. There, a similar classroom was ready for three students who were also enrolled in the same course, but at what was called the "distant" site. Jim, another student director, sat in his Valley Community College studio talking with Jared on the telephone as protocol was reviewed and plans were made for the delivery of this first class period.

A short video segment which introduces all IITV courses began exactly at 4:30 on all three TV monitors, as one instructor, Cathy, began her first IITV course as an instructor. Gary, a second instructor and a veteran at IITV instruction after one course, began the first class in the Valley location and was responsible for that night's content. Students observed introductions by their two instructors; they could see 12 students each with a laptop computer in front of them, either in the Mountain classroom or on the TV monitor. Each laptop had access to the Web, and to a conferencing environment in these classrooms and from home. Some students sat watching the instructors, others were typing on their computer. A few were still trying to set up their computers as class began.

The course, Contexts of Educational Technology, was ready to begin. (Tucker & Gunn, 1997)

A graphic of the IITV classroom (Figure 1) shows just one of several layouts of IITV classrooms at NAU. The course, Contexts of Educational Technology, fit well into the microwave delivery system found in the IITV classroom. A description of the course follows.

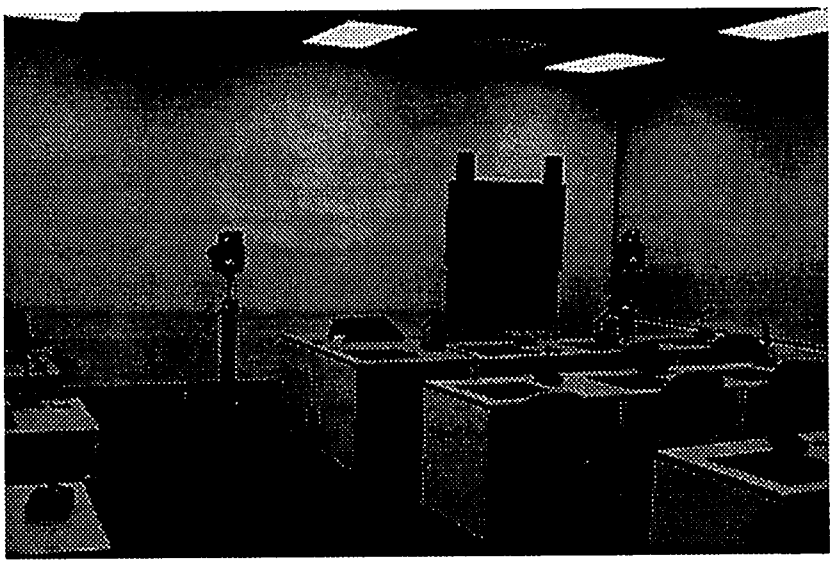

Figure 1. *The IITV classroom at Northern Arizona University.*

Contexts of Educational Technology: The Course

"Contexts of Educational Technology" is an elective graduate course for students in the Center for Excellence in Education's (CEE) Curriculum and Instruction doctoral program at Northern Arizona University. Taught

traditionally in the past as a seminar, the course provides an exploration of historical, social, and cultural views of technology in education. In an attempt to provide students an opportunity to explore content within the context of a highly technical environment, the authors chose to redefine the course and student experiences by delivering it on IITV and with Internet-based Web support and on-line computer conferencing. It was our intention that students could then explore instructional technology issues from a point of immersion which would provide both a more realistic research environment and additional opportunities for active learning through the use of a WWW course homepage, e-mail, and on-line conferencing. Not only would students study historical implications of technology and educational issues, but they would also study the environment they found themselves a part of as they predicted the future of educational technology.

To ensure access to the WWW, email, and a computer conferencing system, students were loaned a laptop computer with a modem and appropriate software. Students were solicited from three communities statewide, but in the final count, 12 students attended class at two locations: Flagstaff (n=10) and a community college in the Phoenix area (n=2). Two masters-level students were given instructor permission to enroll in this doctoral level course; the remaining 10 students were NAU doctoral students. One masters- and two doctoral-level students were focusing on educational technology as a minor area in their Curriculum and Instruction program.

The authors, co-instructors in the course, developed this electronic section of "Contexts of Educational Technology" based on a distributed constructionism model of teaching and learning. A discussion of that model follows.

Distributed Constructionism: The Theory

Establishing a quality learning environment in a distance or distributed education environment is challenging. Rising to this challenge, and based upon our beliefs in the concepts of constructivist learning theories and recent research on the importance of social interactions in the learning process, the co-instructors established up front that the course would be based upon a concept that has been labeled as a distributed constructionism model (Resnick, n.d.). In terms of learning, not teaching, in the distributed education environment, the combination of computing and telecommunications with the cognitive sciences is potentially the most significant issue that must be addressed. The uniqueness of these new highly technologically-enhanced teaching environments found in modern-day distributed education are presenting new challenges in terms of providing quality. We entered this environment with the premise that work in the area known as constructionism, with an "n," could possibly provide some answers into producing the quality learning environments we were looking for.

In social and developmental psychology, according to Von Glasersfeld (as cited in Shaw, n.d.), constructivist models view the learner as a builder of

knowledge, not a passive receptor, but an active constructor. Constructivists believe that all individuals are engaged in creating a vast array of intellectual structures that give order to the world in which they live, and that these structures must support increasing levels of complexity. Constructionist thinking adds to the constructivist viewpoint. Where constructivism casts the subject as an active builder and argues against passive models of learning and development, constructionism places a critical emphasis on particular constructions of the learner which are external, shared, and meaningful.

> We understand "constructionism" as including, but going beyond, what Piaget would call "constructivism." The word with the "v" expresses the theory that knowledge is built by the learner, not supplied by teachers. The word with the "n" expresses the further idea that this happens especially felicitously when the learner is engaged in the construction of something external or at least shareable. . . . This leads to a model using a cycle of internalization of what is outside, then externalization of what is inside and so on. (Papert, 1990, p. 3)

Constuctionist thinking concurs with the constructivist viewpoint but highlights the notion that it is through the construction of shared outcomes or meaningful artifacts that learners engage in developmental cycles that facilitate conceptual change (Shaw, 1996). Evard (1996) states, "Sharing a creation can result not only in its refinement, but also in the learner obtaining a deeper understanding of other people's perspective on the object and on the ideas to which it is related" (p. 224).

Constructionism highlights the notion that through the process of constructing shared outcomes and meaningful artifacts, doors to understanding are opened. Distributed constructionism extends the constructionist view by stating that the social relations and social activities within a learning environment are constructions themselves and have a major impact on the shared outcomes. Distributed constructionism focuses specifically on situations in which more than one person is involved in the design and construction of activities. It draws on the work of Vygotsky (1978) and recent research in distributed cognition (Salomon, 1994). By highlighting the effects of social interactions on cognitive development, Vygotsky (1978) revealed a critical role that external activities play in creating internal constructions. Vygotsky clearly views the external component, the shared and communicated experiences, as being primary in many key instances in that they initiate certain critical internal components through the process of internalization (Shaw, n.d.). To distributed constructionism, the social setting itself is an evolving construction. "When members of a social setting develop external and shared constructs, they engage the setting in a cycle of development that is critical to determining the setting's ultimate form" (Shaw, 1996, p 177).

Social settings are not viewed as simply neutral ground in which developmental activities take place, but they are seen instead as intimately

involved with the process and outcome to that development. By directing particular attention to external constructions of the active learner, distributed constructionism reveals that learning involves more than just creative action; it involves an interplay between internalized and externalized experiences within social settings in such a way as to promote further creative activity.

Much of the literature on constructionist theory is based on the application of the computer in the learning environment (Papert, 1980, 1990, 1993; Kafai & Resnick, 1996; Resnick, n.d.; Shaw, 1996). However, this is not the only place where we are seeing aspects of this theory advocated. Applebee (1996), from his work on the teaching of literature in American schools states, "I will argue that the power of education is intimately bound up in the social and cultural traditions within which education is set" (1996, p. 1). He argues that the social and cultural traditions that exist within a classroom are the knowledge-in-action out of which learners construct their realities as they know them. The paradox of what he calls "knowledge-in-action" is that, in order to learn something new, one must do what one doesn't know how to do. The way out of this paradox is to realize that learning is a social process: we learn to do new things by doing them with others. Applebee continues by saying if students are going to learn within the classroom by "doing with others," they will do so through their participation in the language and the culture of that classroom. This concept "leads to a new way to think about curriculum and instruction: A curriculum provides domains for conversation, and the conversations that take place within those domains are the primary means of teaching and learning" (Applebee, 1996, p. 37).

When viewing the design of a curriculum in this light, then a curriculum provides for what Applebee (1996) calls "culturally significant domains for conversation." He contends that the problem of curriculum planning is the problem of establishing a culturally significant conversational domain and fostering relevant conversations within it. According to Resnick (n.d.), a particularly effective way for these culturally significant domains for conversation to form and grow is through collaborative activities that involve not just the exchange of information but also the design and construction of meaningful artifacts.

> Learners are most likely to become intellectually engaged when they are working on *personally meaningful* [italics added] knowledge activities and projects. In constructionist learning, forming new relationships is as important as forming new representations of knowledge. (Kafai & Resnick, 1996, p. 2)

From this shared personal belief, we concluded that in order to create a quality learning environment, two important aspects of classroom design were important in our planning. First, we believed it was important that the curriculum in some way create an environment where conversations would occur that resulted in learners actively constructing and reconstructing

knowledge. The second belief that guided our planning was that knowledge construction would take place when learners were engaged in personally meaningful activities and projects.

Selection of the Worthwhile: Course Design

There are a host of unresolved issues associated with distributed constructionism, many of which we encountered. One such issue is the inconsistent use the terms "social constructionism" and "distributed constructionism" in the literature, to refer to the same theoretical model. Based upon the definitions we have established above, we will use the designation of distributed constructionism in reference to the theoretical model we were attempting for the basis of this course, but, in order to preserve the integrity of quoted materials, we will use the exact terminology of the various authors.

We used a "shell" course or syllabus as the mechanism for addressing a dilemma of "worthwhile-ness" or personal meaningfulness.

> The *Shell Course* is an activity template that enables the students to generate the information base for the course as they do their research. They may study communities or build worlds that do not yet exist through team research, brainstorming and innovation. Such courses are extremely popular because they push the frontiers of knowledge, challenge students physically and intellectually, offer opportunities for imagination and creative thinking, and foster stimulating group interactions. (Perrin, 1996, p. 8)

The shell for our course was created by providing students with the context within which all interactions must occur. To implement the concepts of distributed constructionism stressed by Kafai and Resnick (1996) and Applebee (1996) within the structure of this shell, we, as instructors, had to facilitate a process that would create "culturally significant domains for conversation" and from these conversations students were required to create meaningful artifacts. If these domains were to be significant to the learners in our course, then we believed it was critical that the students in this course be involved in the process of negotiating the domains for conversations. It was through these conversations that the curriculum really developed, so the selection, or what was contained in the curriculum, was a community effort of instructors and students. "This was a convenient shorthand for making the point that any curriculum is a *selection* [italics added] that represents what a community believes is worthwhile" (Applebee, 1996, p. 42).

To begin the process for creating domains for conversations and to facilitate the creation of meaningful artifacts, an iterative theme paper with drafts informed by cumulative readings and course discussions was assigned to students (with instructors engaging in the same assignment with students). In this case, "iterative" describes a narrowing process for refining ideas in writing

theme papers. Students chose a topic to write about for the first iteration. The second iteration paper required students to continue with the same topic but to refine the paper based on class conversations and on new readings and understandings. For iteration three, the individual theme papers were to fit into larger domains determined by class consensus. These negotiations were accomplished by using a community development process, similar to the qualitative Delphi technique of soliciting the best thinking and then feeding back the findings for a second and third round. Upon the completion of the third round, author groups were identified by their ability to share the desired "culturally significant domains for conversation" (Applebee, 1996, p. 49) to the point that the instructors conjectured the students could be collaboratively engaged in the construction of something that was meaningful and shareable. Each group, through collaborative activities, was to produce a meaningful artifact in the form of a final paper. The papers would follow manuscript guidelines of a professional journal of their choice. The negotiated end product was a collaboratively-produced manuscript, suitable for publication, that addressed the issues of their particular domain. Below is a summary of the three domains for conversation which tied theme papers together.

> The first domain of conversation concerns the need for planning and decisionmaking concerning the use of technology in the teaching and learning environment. The four authors (three students and one instructor) all agree that technology itself will not be enough to enhance the learning environment and they question the decisionmaking process. All agree that intervention in the form of planning and doing things differently will be necessary for educational technology success.
>
> The second domain of conversation concerns the impact of technology on teaching and learning environments. Though all the authors (seven students and one instructor) have strong faith that technology will enhance learning, there is concern voiced as to how this will be determined and who will measure the enhancement. The authors approach the domain from different perspectives but establish that technology is here to stay in the classroom.
>
> The third domain of conversation is in the area of teacher training and support using technology. The four authors (students) approach the subject of teacher development differently, but all identify teacher development and support as crucial for educational technology success. (ECI 751 on-line course document)

A second major assignment came out of the negotiation process between the students and instructors. The students expressed a desire to explore and experience the creation of quality learning environments utilizing ITV, Web-enhancement, and computer-conferencing. To facilitate this assignment, students developed team-prepared teaching lessons which explored an

educational technology topic determined by group consensus. Lessons were taught within the IITV environment utilizing the specific technology they were exploring. To support this process, instructors selected a basic reading packet of articles and on-line resources to support conversations, and students were encouraged to add to that packet of materials as conversational domains were refined.

Finally, we asked the students in this course to study the environment with us. They were taking a graduate course on the contexts of educational technology. It seemed appropriate that they take the course as both students and as researchers. As researchers, students were asked to include observations of the learning environment in class journals. Students were included in the development of the research design and in gathering and analyzing data.

Paradigm Paralysis

On reflection, this course opened our eyes to this: if we are truly going to create active learning environments, a shift in beliefs and *behavior* is necessary. This means a paradigm shift, a total shift in the way we think, how we approach teaching and learning, and how we operationalize our beliefs. One instructor's personal journal entry below depicts her personal experiences in what Hooker calls a paradigm paralysis: difficulty changing the way we think and the way we behave (1997, p. 27).

> I have always thought that I do a good job of gauging student engagement, because I often stop midstream and go another direction when necessary. . . . Well, I could feel myself pushing on, pushing on, not recognizing when it was time to do anything I typically do in a class session. I was without clues. . . . Why? I couldn't read the clues. Why? I couldn't see the clues: body language, sparkles in eyes, glazed eyes, closed eyes, fidgets, reading books for pleasure, leaving to order a Big Mac . . . the technology this time did not allow me to use what I know. . . . Classrooms as I know are SUPPOSED to provide eye-contact. . . . Classrooms as I know are SUPPOSED to provide an environment that lets me see how I'm doing, how the students are doing and adjust accordingly. (Instructor Journal Entry)

The course proceeded in ways we didn't expect. For example, we found that whenever we were in a situation that was unfamiliar or uncomfortable, we reverted back to our old teaching styles–usually a lecture format. This occurred with both instructors, even though we had every intention of creating active learning environments for our students. We had not expected to encounter difficulties in transferring beliefs to practice. While students were encouraged to participate actively, instructor practice may have hindered operationalizing the distributed constructionist approach as we found ourselves in a paradigm paralysis: what we believed and expected of ourselves as constructionist teachers versus the reality of our traditional practice.

Creating domains for conversations is just as important a concept for teachers as it is for learners. The IITV classroom environment presented challenges that we were not prepared for. Students at the distant site are seen on a TV monitor and can appear to be a group rather than individuals. Their image is quite small and details are not readily available such as facial expressions, physical manifestations from frustration, or comments to nearby students. An instructor viewing a portion of the class via TV monitors can miss important clues that indicate emotional climate or understanding of concepts.

The originating site where the instructor is located may range from a full classroom of students to no students. Speaking to an empty room, or to a class of two or three students, with a TV monitor to represent the rest of the class, is an unusual and unsettling experience. The following instructor journal entry provides more detail on why the experience was found unsettling:

> Valley Classroom: 3 people in front of me, 2 taking notes on their laptop. I used one person to gauge barometer of class because I could make eye contact. Talking in front of 3 people is like talking in a meeting–it isn't often we have so few people in front of us when we teach.
>
> NAU's Flagstaff Campus classroom: 12 people seen from a monitor at my side and one in the back of the room. While they were seen on a large screen, I got only a bird's eye view of the class (except for 2 close-ups later in the class when 2 people talked long enough for Jared, the camera person at NAU's Flagstaff Campus classroom, to zoom in.) That means I could not see any one person individually, especially not with eye contact, and instead, I have a remembrance of "a class" rather than 12 individuals. The view was so far away that I could not tell if anyone was absent, and in some cases, I could not distinguish one person from another. I can not tell you today where more than 2 people sat that night. . . . If you tried to get a word in edgewise by raising your hand, I would not have seen it.
>
> You all ceased being individuals and became a "mass." . . . In reflecting on this occasion, it occurs to me that I am learning a lot about myself as a teacher. I NEED to see the "whites of their eyes" to gauge the interaction and buy-in from students. (Instructor Journal Entry)

We were in the process of trying to create change but found ourselves being part of the change itself. Our thinking about the technology "caged" us within such parameters that when we were disconcerted by the change and tried to go back to the comfortable traditional standards of operation, we were not successful. Not only were we not successful in creating the new paradigm, even when we went back to the old paradigm, we found it lacking. We were in the midst of a paradigm shift, caught in the middle. The old ways did not

produce the learning environment we wanted, and we did not yet have the expertise to create the new learning environment we desired. We had begun to change our way of thinking, but we had difficulty changing the way we behaved–a classic case of Hooker's Paradigm Paralysis.

Cultural Paralysis

We were faced with new rules–rules that were unknown to us. In this context, we define "rule-breaking" as the written or unwritten, acknowledged or unacknowledged customs, traditions, and understandings found in the learning environment created. For example, students were expected to play a different role–that of a collaborator with the instructors. Neither students, nor instructors knew exactly what rules to play by as we explored these unfamiliar roles. A second example of not understanding occurred when we held our first on-line chat using a conferencing software. The chat took place in the university classrooms in order for us to test the system with the back-up of face-to-face support if the chat session didn't work. To allow students to explore the environment, a question was asked by the instructors for students to respond to and to begin a discussion. There was confusion in the chat area as lack of turn-taking and diverging conversations occurred. This on-line environment was unknown to most of the participants, including the instructors, so the rules and traditions we were accustomed to no longer seemed valid. A third example occurred when we held on-line office hours, which included another live chat. Within the chat discussion which ensued, students first asked questions which related to themselves, but soon a conversation developed on a topic raised by one student: authentic assessment. A look at the transcripts of that chat show individuals jockeying for position as lecturers, discussants, and recipients of new information. Both instructors were left in the dust as students took over the discussion and in the end, actually proposed changes in the course grading system and developed new rules for that system. Other less-specific examples include not knowing how to act in new and often untested areas of this environment that was created: students providing direction for the course, negotiating grading procedures, and providing continuous feedback on the learning environment.

> These rules govern how certain categories of persons may act in relation to various other categories of persons and things. The rules, in other words, specify how rights and privileges in persons and things are to be socially distributed. American children are first introduced to this kind of interpersonal scheduling as "taking turns." Anthropologists know of no human community that is without such rules or whose social relationships cannot be analyzed as an ordered distribution of rights, privileges, and duties among well-defined categories of persons. . . . A system of social rules is basically, then, a definition of rights and corresponding duties. . . . The values expressed by a given set of rules are thus the **operating values** of

> those who abide by them; and they are the **public values** of any social group whose members regard observing these rules as a condition of membership in the group. (Goodenough, 1981, pp. 76-77)

Facilitation of learning in this environment meant that we, the instructors and students, often had to break rules first before we could know what the rules were. This can cause real uneasiness in a teacher, but a collaborating duo must work with even more and different kinds of uneasiness as we challenge multiple traditions at the same time that we are asking our students to study the environment with us. Asking students to study the environment with us meant that they were encouraged to explore our rule-breaking and to explore solutions, while at the same time, we explored the students' rule-breaking. In essence, we were developing operating values, both positive and negative.

> The entire range of purposes and interests whose service people associate, consciously or unconsciously, with a customary practice gives it a positive meaning or value for them. . . . At the same time the interests and concerns that are not served and that are even sacrificed give the customary practice a negative meaning or value. Thus meaning and value have both positive and negative valences. . . . As changing circumstances alter people's experience of the effects on them of their customs, the meanings and values of these customs will also change. (Goodenough, 1981, p. 94)

In essence, what we all knew about learning environments, and had practiced in the past, did not always fit the circumstances, nor could we count on the familiar customs. Each class period and every encounter between class periods, was cause for the unexpected and, often, the uncomfortable.

One of our primary goals was to take these students from differing educational backgrounds and agendas, and engage them in conversational domains to facilitate their understanding of the context of learning within this technical learning environment. This process of education is an ongoing dialectic between equilibrium and disequilibrium:

> So long as new knowledge fits into our present mental structures, we are pretty much in a state of equilibrium. But when experiences and new knowledge do not fit within these structures, we encounter disequilibrium–a challenging and sometimes painful situation. Then, through a process of integration and appropriation, we either incorporate the new knowledge in our existing mental structures or construct new ones, thus returning to equilibrium. (Meyers & Jones, 1993, p. 29)

The semester was a constant period of disequilibrium. As instructors, we assumed throughout this course that we were engaging students in dialogue

and facilitating so that "something in the world changed as a result of the student's action" (Laurillard, 1993, p. 100). We asked ourselves, "How does one teach for understanding, or engage in constructionist teaching?" Our goal was to create an active learning environment, to support our students' thinking, but not to do the students' thinking for them or expect the students to think as we did.

It was our assumption at the beginning of the semester that if we had access to good ideas on teaching strategies that supported our belief in constructionist teaching, we would know how to put them into practice. We also expected students to interpret our assumptions, our goals, our intents, and to transfer these ideals to their own practice–at least the practice we would see in this one classroom. We felt we needed to direct students toward the creation of meaningful artifacts within the context of the learning goals of the course. Despite our ambitious ideals, we didn't know how to do it. That lack of understanding of how to operationalize constructionism changed the course direction we were trying to create. Instead, we created our own chaos. In the next section, we attempt to analyze that chaos which resulted.

Analysis of Paralysis: Course Reflections

To introduce this section a point/counterpoint format will be used because for every negative experience we want to share, we have a positive counter point. Each negative experience resulted in a positive learning experience, as seen in Table 1.

Constructionist Dilemma: Defining Roles and Responsibilities

Our passion and convictions for what students needed to know in order to understand were obviously at odds with our views on how students learn, resulting in a constructivist, or constructionist dilemma. So now, we ask ourselves the question that has been asked by many before us, what is the role of the teacher, and the student, in a learner-centered model? Alternatively, if the object of teaching is to help students link feedback on their actions to the topic goals at every level, how much should the teacher actively intervene to provide feedback and to help students link that feedback to their actions?

> How teachers teach at any given time is a composite of how they taught in the past, how they think they ought to be teaching in the present, and how they reconcile the latter with the former.... Teachers are active decision makers who are constrained in their capacities to act on new ideas by their past practice, by their judgments about what is worth doing, and by deeply rooted habits that are often at odds with their own espoused views of what they ought to do. (Elmore, Peterson, & McCarthey, 1996, pp. 238-39)

This constructionist dilemma may occur in part because students also learn at any given time as a composite of how they have been "taught" to learn

Table 1
Negative Experiences Lead to Learning Experience.

Perceived Negative Experiences	Learning Experience Resulted
Teaching to a TV screen, we fell back on what we knew best - lecturing.	Everything became public and we began to reflect on our beliefs and practice.
Some students came into the course with extensive experience within the constuctivist (with a "v") paradigm. Our behavior and the course design only seemed to indicate to them that we didn't know what we were doing as we shared our reflections and involved them in our questioning and findings.	Some of these same students and other students became colleagues and grew in this constructionist environment as we shared our reflections and involved them in our questioning and our findings.
A Delphi strategy was a community development process used to determine meaningfulness; some students refused to participate. We were later criticized because we didn't meet their agenda.	The Delphi provided meaningful construction for other students. The process provided for them an avenue for conversations and, through conversations, meaningfulness occurred.
One student's constant obsession with grades wore us down as we encouraged students to develop self-evaluations.	The rest of the class engaged in a meaningful on-line chat (without instructors) about authentic assessment that had a tremendous impact on the worried student. One of the highlights of the course was to read this student's journal and watch her personal growth and understanding of her changing role as student.
Lowest student evaluations received for a course by instructors.	Evaluations have provided the opportunity to make our thought processes/reflections available for peer reviews and yearly evaluation; we are addressing student concerns publicly tied to our scholarly line of inquiry.

and how they think they ought to learn in the present. Many adult learners enter the classroom environment with knowledge constructed from past experiences and with a need to share those experiences and knowledge. But, at the same time, many students may have been conditioned to expect the transmission metaphor for learning, that of an "efficient flow of information down the pipeline," presumably to an empty vessel, themselves (Tiberius as cited in Meyers & Jones, 1993, p. 5). What many learners don't have is the experience to be able to function well within this paradigm.

It was not only the instructors who found themselves in an unfamiliar setting; many of the students insisted on doing things the way they had always done them and some were extremely critical of the expectations placed on them to help design and construct the learning environment. Some students found themselves in the same paralysis that we were experiencing and struggled to move past the technology, bogging down in procedures. Students and instructors grappled with both too much flexibility and then not enough; with too many expectations and then too few; with too much conversation and then too little. How does one create the types of collaborative activities we were after? How does a teacher manage the negotiation process so that both the individual student and the discipline receive their just due? Prawat and Floden (1994, p. 48) describe this as the "constructivist dilemma" (see Gunn chapter, this monograph, for discussion of constructivist dilemma).

One student reflected in her course journal: "The possibilities of change are only as prominent as our willingness to change our context of learning" (Student Journal Entry, 3/25/97). Not all students in this class appeared to be ready to engage in conversations about change, nor did they seem open to changing their "context of learning." Several students didn't buy in to our invitations to participate as active learners. Assignments were not completed by some, there was an obvious lack of participation in determining content or process, and several students were actually hostile in class and in written journals. They were not effective in creating and engaging in conversational domains, often dwelling on the mechanics of the course and process rather than on content.

In contrast, one student in particular, thoughtfully provided positive feedback to the instructors about the value of the experience and engaged in high-level conversations. However, many other students were openly critical and less successful in their roles as active learners. Several students admitted that this course forced them to move out of a security zone and they had difficulty dealing with this. When they were experiencing this anxiety, several students seemed to call for more course structure (e.g., grading rules, page length, minimum standards).

Situating Curriculum

What can we do as instructors to work through this paradigm paralysis with students? Again, according to Applebee (1996, p. 108), the paradox of what he calls "knowledge-in-action" is that in order to learn something new,

one must do what one doesn't know how to do. This lack of experience and practice seems to set both instructors and students up for a constructionist dilemma, which creates more uneasiness as we become more entrenched in our paradigm paralysis, relying on those teaching and learning strategies that are deeply rooted habits of past practices or beliefs. The way out of this paradox may be to realize that learning is a social process; we can learn to do new things by doing them with others.

In general, the way we structure our curriculum can shape the success of knowledge-in-action. Applebee (1996, p. 49) argues that schooling should be organized to help students enter into culturally significant domains for conversations.

How, then, do we as curriculum designers "place the emphasis on entry into such conversations," stress "culturally significant domains," and "domains for conversation?" From our experience we cannot yet offer a solution. We believe that if true learner-centered environments are to be created, we must pay attention to the way we structure a curriculum with close mindfulness on this concept of providing experiences for learners that will furnish opportunities for engaging in culturally significant domains for conversation. From our experience, we have found that providing a scaffolding for students as they learn to participate in conversations within the domain is critical. We found that certain students were unable, at first, to participate in significant conversations, but by the end of the course, their conversations were so significant that they were leaders in determining the structure of the final artifact. Other students never seemed to move into the conversations to a point that they produced significant impact on the domain. We suspect that there is plenty of blame for all. What is significant is that, for whatever reason, the scaffolding was not there or was insufficient for these students to allow them "entry into the conversations."

> Knowledge arises out of participation in ongoing conversations about things that matter, conversations that are themselves embedded within larger traditions of discourse that *we have come to value* [emphasis added] . . . the development of curriculum becomes the development of culturally significant domains for conversation, and instruction becomes a matter of helping students learn to participate in conversations within those domains. (Applebee, 1996, p. 3)

The solution for providing the necessary scaffolding may be in a critical aspect of the constructionist theory that is referred to as the creation of *meaningful* artifacts. The solution for helping learners enter into conversations within culturally significant domains may lie in the ability of the instructor and the learners to negotiate meaning–a process that is a "two-way-street."

So, through reflection, we continue to investigate our past teaching behaviors and the characteristics of active and constructivist learning environments, of constructionism, to move towards that deep systematic

knowledge of practice. Just how is this orchestration of curriculum towards active learning and constructionist thinking to take place? The answer may come from a methodology called phenomenography, coined by Marton (as cited in Daniel, 1996, p. 107) to mean "description of the phenomena." Knowing alternative ways that students conceptualize key phenomena, which include the concepts of reality they have already acquired, is critical. What this results in is the shifting of focus from what the teacher should do to how the teacher must set up the interactions.

Going Public: The Emperor's New Clothes

But we must make a confession: at the beginning we were only kidding ourselves about who we were as teachers. If asked, we would have described ourselves (and often did!) as good teachers, using constructionist thinking, and creating active learning environments for our students. Our bluffing became public when we engaged in collaborative reflection with each other and with our students throughout the course. We then found ourselves scrambling to determine what we *really* believed in as teachers, and we began trying to make changes in our teaching practice "on the run," so to speak.

Fullan suggests that "it is possible to change 'on the surface' by endorsing certain goals, using specific materials, and even imitating the behavior *without specifically understanding* the principles and rationale for the change. Moreover, . . . it is possible to value and even be articulate about the goals of the change without understanding their implications for practice" (1991, p. 40). As teachers, we may use materials and technology with no real understanding of the changes in beliefs or behavior required to make them work as intended. In other words,

> individuals can feel as though they are engaged in substantial changes either because they are using different technologies or materials or because their beliefs about what they are doing have changed. But the educators may have changed their actual *behavior* very little, if at all. (Elmore, Peterson, & McCarthey, 1996, p. 8, emphasis in original)

Choosing to teach a course through IITV and Web-enhancement created a false sense of change in teaching practice that was, thankfully, uncovered. We think it was exposed because of the serendipitous nature of team teaching as we encountered and reflected on our shared constructionist dilemma.

Improving With Practice

We have had a limited opportunity to expand on our experiences since the course described herein. For both instructors, the second and third time around have resulted in improved student response and responsibility-taking. What specific actions may have supported these improvements?

1. Practice by instructors. We expected to "get it right" the first time and surprised ourselves when our facilitation of the learning environment created

wasn't up to our standards. We recognize that the constructionist environments we strive for may require more time than we anticipate as we continue to practice newly-learned strategies.

2. Increased reading and reflecting both singly and collectively; continued conversations on the "how" of teaching. Several presentations, articles, and a book chapter later, the words still don't come easy. What we do find is that whenever we make time to plan and discuss, the "aha's" and the thrill of understanding what it is all about are welcome.

3. More active learning episodes versus lecture-based sessions. Practice did seem to have helped here. We found ourselves wandering in our classroom at times, not needed, as students worked together or apart on set tasks that they often set for themselves. We paid more attention to how we set up the interactions and negotiated meaningfulness.

4. More structure in the syllabus on expected goals and outcomes but continued flexibility in process. Students helped develop direction of the course, but not as much time was spent on negotiating every component of the shell syllabus. Chaos was less evident as we provided a true shell of form and function. Students were still very much involved in direction and were provided numerous choices with the syllabus providing a guide.

5. The addition of off-line discussion items versus real-time chats. Students had the time to reflect and follow a discussion theme in more depth. We asked ourselves the questions "Why are we doing what we're doing?" and "Is this the best and/or the most effective medium to use right now?"

Conclusion: Calling for Conversations

What we are learning in our investigation of our teaching practice is that one experience will not adequately tell our story, just as our practice is unlikely to change much without more exposure to what teaching actually looks like when it is being done differently. In higher education, as well as in the K-12 traditions, we haven't always talked with each other about teaching. The only way we'll ever be able to accomplish this change in behavior is by doing it and by asking difficult questions–and then by reflecting on the doing and coming to know more about the answers to the questions. In the doing, we may fall flat on our face or experience embarrassment and failures (including lower student evaluations), but the only way we can really make changes in behavior is by doing it. It isn't that our past ways of doing were wrong or bad. The point is that the future will be different. And so from our doing, our questions, and our reflecting, we present you, the reader, with descriptions and reflections that may be helpful in your own exploration of the learning environments you help create.

This chapter suggests that conversations about teaching and learning environments are one way to help us see what teaching looks like when it is done differently. Meyers and Jones (1993, p. 3) comment on these conversations:

> Though hardly a revolution, this conversation about teaching breaks a long tradition reflecting on almost feudal mentality in which teachers surrounded their classrooms with psychological moats and fortifications. The lords and ladies of academe seldom discussed what went on within their castles. And, when the teaching nobility did meet, their conversations revolved around research and discipline-related issues–not teaching.

Greene tells us that to come to reflect, to come to see is to learn (1978, p. 84) and calls for "wide-awakeness." It is that wide-awakeness that has led us to this public monologue calling for greater dialogue or conversations in the practice of our teaching. There is a Chinese saying that goes: "The fish is the only one who does not know that he swims" (Anonymous). Ackermann tells us that

> People cannot learn from their experience as long as they are entirely immersed in it. There comes a time when they need to step back, and from a distance reconsider what has happened to them. They must take on the role of an external observer, or critic, and they must revisit their experience "as if" it were not theirs. They need to describe it to themselves and others and in doing so, they will make it tangible. (1996, p. 29)

We have attempted to revisit this experience as if it were not ours. In this chapter, we have engaged in Ackermann's "dance between diving-in and stepping-out" (p. 28) in an attempt to make the experience tangible. But what have we learned about this teaching in the context of a distributed learning environment, where technology can enhance or appear to be a barrier to a constructionist belief system? Because we are in the process of integration and appropriation as we write this paper, we probably don't have a realistic view–we probably weren't as bad as we thought! This "lord and lady of academe" have found ourselves in real conversations about our teaching–something we haven't done all that much before. We continue to discuss our experience from several points of view and within an understood context. As we pay more attention to our own and our students' reflections, we find ourselves able to see alternatives to our practice. We invite a larger circle of conversations to take place with us.

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